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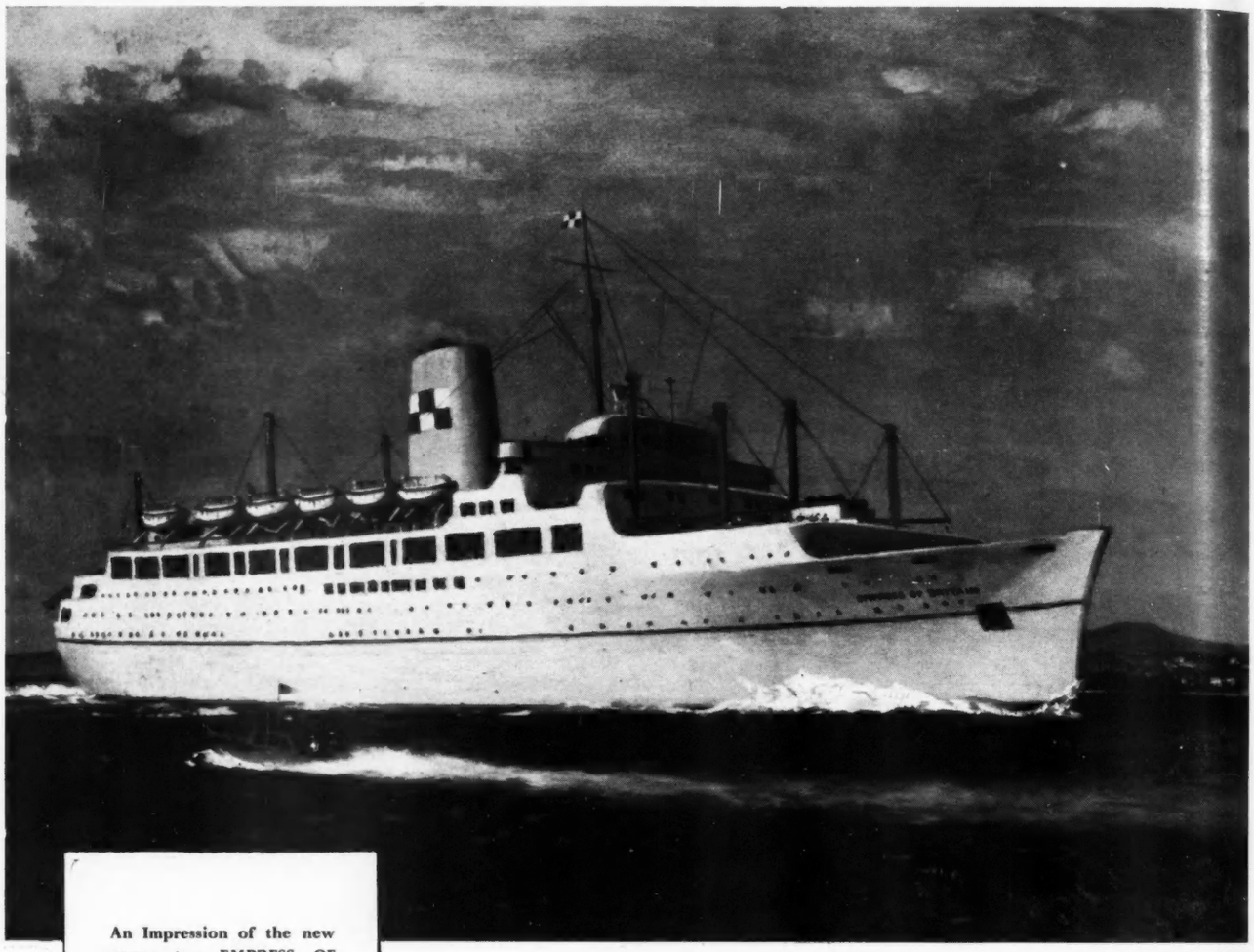

An Impression of the new 24,000 ton EMPRESS OF BRITAIN in the St. Lawrence, from the oil painting by Norman Wilkinson, C.B.E., P.R.I. Reproduced by kind permission of the Canadian Pacific Railway Company.

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An Illustrated Weekly Journal

Vol. 180 No. 4668 JULY 15, 1955

Leading Article

"Political Innocents" 65

Weekly Survey

Dependence on Engineering 66
Power: Land and Sea 66
Diesel Engine Costs and Competition 66
Tempered Optimism 66
Shocks for Industry 66
Standards in the Motor Industry 67
Rolls-Royce Export £13 Million 67
Leyland Motors in India 67

Principal Articles

Transport and Engineering: Summer Meeting of The I.Mech.E. 68
Fifty Years at Farnborough: Golden Jubilee of Royal Aircraft Establishment 71
Anglo-American Conference on Aeronautics: High Speed Problems, Large Helicopters, and Pressure-Cabin Fatigue 74
British Electrical Power Convention: Productivity, Careers in Industry, and Future Needs 75
Aluminium-Alloy Concave Pointed Rivets: Small Loads Suffice for Closing 79
Central Electricity Research Laboratory: Extension for Wider Range of Investigations 84
Forming Components from Strip: Large Four-Slide Machine 85
Combination Two-High and Four-High Rolling Mill: A Versatile Unit for Research or Production 86
132-kV Substation at Castle Donington 87
Centralising Information from Remote Sources: System for Cash Registers 87
Lorry with Extra-Wide Tyres: Use of Twin Engines 87
Dynamic Balancing Machines: Range Extended to take Workpieces of 100 lb. 88
Manufacture of Ductile Iron: Magnesium Addition in a Closed Vessel 88
The Gasification of Heavy Fuel Oil: Proposed Solution of Furnace Problems 89
British Instrument Industries Exhibition 90
The Royal Show at Nottingham 92
Roads for Motor Traffic Only: 345 Miles to be Built in Ten Years 94
Down-Grip Machine Vice 96

Letters to the Editor

Opportunities for Young Engineers 69
"The Inquiring Mind" 69
Torsional Vibration in Marine Propellers 69

Obituary

Mr. E. E. Hoadley, C.B.E. 69
Mr. E. P. Muntz 69
Professor G. Magnel 69
Mr. F. D. Power 70

Book Reviews

Practical Gear Design 73
TV Stations 73
A History of Technology 74

Notes

Nuclear Power and the Public 72
100-Watt Vibrator 78
Rubber to Resist Hot Lubricants 85
Instruction Course in Furnace Brickwork 85
Air Starting for Smaller Diesels 86
Wheel Pullers 88

Personal 70, Commercial 70, Contracts 71, Books Received 79, Launches and Trial Trips 93, Labour Notes 96

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"POLITICAL INNOCENTS"

THE scientists' statement on nuclear war was critically received by the daily Press. Some of Monday's newspapers did not even trouble to comment on it, and of those that did the tenor of their remarks was typified by a leading article in *The Scotsman*, commencing "Scientists are sometimes political innocents."

However just that may be it is an incredible retort to a solemn warning by a group of the world's most illustrious scientists on the possible destruction of mankind. That kind of comment prompts the question: How accurately does the Press reflect public opinion? For there can be little doubt that men and women were chilled by the statement at the week-end, and many of them must have looked in vain for a lead from their newspapers. But there must be some explanation; Fleet Street is, in fact, a most sensitive indicator of public opinion. The answer is doubtless to be found in a popular feeling that since scientists were responsible for developing nuclear weapons it ill-becomes them now to pronounce on the calamity that faces humanity. The statement, it has been argued, contained nothing that was not known already, and there was no necessity for eminent scientists to re-state it. It was described as "platitudinous," and the form of its presentation as "rather portentous."

In trying "to say no single word which should appeal to one group rather than to another," the scientists evidently said a number of things that offended. They asked their audience to consider themselves "only as members of a biological species which has had a remarkable history and whose disappearance none of us can desire." That choice of words upset a number of commentators, who read into it an unspiritual, unethical, even unhumanistic approach that was naturally alien to them. It was an unfortunate, and presumably unintended, reaction. The scientists, after all, were addressing the whole of mankind, and the only view of themselves on which all members of the race would agree is the "biological species" view. They would certainly not agree on the spiritual, ethical or humanistic views.

The fact remains, however, that the statement has been widely misunderstood, even rejected. The *Western Mail* was one of the few newspapers to accept it in the spirit in which it was prepared. It will be "one of the great landmarks in history" this paper said, and perhaps that comes nearest to the truth. In rejecting the statement most newspapers have voiced the general opinion that the problem created by nuclear weapons will be handled better by statesmen than by scientists. This attitude, apart from being realistic, is welcome because it shows that the awful responsibility is generally accepted. Scientists are not expected to assume a special responsibility.

Nevertheless, the statement can have done no harm and may do a power of good. Coming, as it has, on the eve of the Geneva "summit" conference, it has emphasised the paramount importance of these talks. And it has done so in a way which will certainly reach all the statesmen concerned. The chief purpose of the appeal is to call for an international conference of scientists to "appraise the perils that have arisen" and to discuss a resolution which, if carried, would urge the governments of the world to realise, and to acknowledge publicly, that their purposes cannot be furthered by a world war, and "we urge them, consequently, to find peaceful means for the settlement of all matters of dispute between them."

Who would promote such a conference? It is certainly not beyond the power of a learned society, but the poor reception given to the statement may militate against the idea. If it were taken up, such a conference would probably modify the draft resolution appreciably before carrying it. Indeed, it is already apparent that some scientists would not support the resolution. Nine of them, including the late Albert Einstein, signed the statement, but Lord Russell approached 19, and since publication an American scientist and Nobel Prize winner, Dr. Harold Urey, is reported to have labelled it "futile" and "completely obvious."

Maybe it is. Perhaps men are everywhere conscious of the meaning of nuclear war. We are inclined to doubt it. It seems to us that many, finding the prospect too appalling even to contemplate, prefer to suppress it in their minds. A mood of fatalism descends, tempered by a vague hope that, in fact, no government will be so rash as to precipitate an unlimited war. This is the mood, surely, that Lord Russell and his fellows seek to sweep away. Men's material needs and wants are recognised, without much difficulty, by governments; it is, indeed, the sum of our material needs and wants that gives a government power. Unfortunately, mankind's universal desire for peace is not something that can be similarly promoted, like the desire for rubber or bananas. It is not passed up from one government department to another, reaching the Cabinet offices as a statistical report for consideration and necessary action. It fails to fit in with the machinery of governments. But perhaps there are other ways of keeping it in the forefront of international political thinking.

Weekly Survey

Cover Picture. *Locomotive No.* 34034, "*Honiton,*" *is a Southern Region West Country class engine with the enclosed valve gear developed by Mr. O. V. S. Bulleid from the Walschaerts type. It is shown under repair at Eastleigh Works, one of the* 19 *main railway workshops of the Transport Commission. The annual turnover of these and two motor-vehicle workshops is stated to have been "of the order of* £70 *million" in* 1954.

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DEPENDENCE ON ENGINEERING

With the holiday season fast approaching and the dock and rail strikes behind, the moment is opportune for a glance at the prospects until the turn of the year. It is now just over four months since the Government took its latest measures to restrict credit as a means of safeguarding the balance of payments. Last week, the Chancellor of the Exchequer addressed the National Production Advisory Council on Industry and dealt with the nation's economic health in retrospect and prospect. He considered that the measures taken in February had enabled the economic position to be stabilised; credit restriction could be seen to be in operation by the fall in the banks' net deposits which had been reinforced recently by the letter from the banks to customers advising continence in applications in bank advances; there were "certain signs" of a check in the upsurge of personal consumption; opportunities for exports should increase as the recovery in the United States develops its momentum. Furthermore, the trade prospects with Western Europe are also quite good. Generally, the international climate is one of expansion, according to the Chancellor, notably in Western Europe and in the United States, so this country can look forward to growing trade provided costs are kept down. There are indications that Britain's efforts to contain cost increases have been less successful than other countries of late and the Chancellor does not underestimate the disorganisation to exports which the recent strikes has caused. On the whole, however, his diagnosis is favourable.

It takes quite a number of swallows to make a summer and it may be that from the vantage point of the Treasury the Chancellor may see more harbingers of summer than are vouchsafed to the general public. Although net deposits have decreased, it has been by the banks selling securities rather than by any restriction of credit so far. The hire-purchase restrictions announced in February have had very little impact on consumer spending (except in a few lines of domestic appliances), unless certain information is available which has not yet been published. With the best half of the year gone so far as the gold and dollar reserves are concerned, with industrial production running at about 7 per cent. higher than at the same time last year (subject to any adjustment that has to be made because of the railway and dock strikes), with unemployment moving towards a record low level and in consequence a prospect of a high level of imports in the second half of the year, there is a good deal of inflationary potential about. Much depends on the ability of the economy to keep exports buoyant for the rest of the year if prosperity is to be built up still further before the next Budget is due. It is becoming increasingly clear, too, that an ever-growing burden in this respect is being placed on the metal and engineering industries, for such traditional exporting industries as cotton textiles and hosiery are having a very mixed experience abroad.

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POWER: LAND AND SEA

Demand for power equipment for electrical generation and for ship propulsion has never been so high. Richardsons, Westgarth and Company, Limited, who are fortunate in having an interest in both fields, are therefore able to report in their recent annual statement that their four works are operating at full capacity. Orders for marine turbine machinery and for a further six turbo-alternators with a total capacity of 240 MW, together with water-tube boilers and other equipment for industrial customers, ensure a period of intense activity at Hartlepool. Not unexpectedly, orders for steam reciprocating machinery has been falling but this is offset by increased demand for oil engines. Richardsons, Westgarth's subsidiary, North Eastern Marine Engineering Company, have a full programme for the manufacture of Doxford engines over the next few years. The increase in demand for Diesel engines for smaller vessels, for which another subsidiary, George Clark (Sunderland) Limited, cater, has also been marked. The range is being extended and orders have already been received for Clark-Sulzer engines of 4,000 and 6,000 brake horse-power. The versatility and range of applications have been extended by supercharging and the ability to use heavy oil fuel. Clarks are increasing their test-bed equipment to deal with engines up to 16,000 brake horse-power.

At the present flux of power development, Richardsons, Westgarth are naturally looking beyond the Diesel engine and the steam turbine with conventional steam-raising equipment. They have already completed their first gas-turbine control—a 2,500-kW unit for the Shelton Iron, Steel and Coal Company. As Mr. O. J. Philipson, the chairman, states, progress in atomic energy is more advanced in its application to produce electricity than in its possible uses for marine propulsion. However, steps are being taken to ensure that the Group will be suitably placed to participate in atomic developments in both fields.

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DIESEL ENGINE COSTS AND COMPETITION

British output of industrial and marine Diesel engines was high in 1954. In his recent annual statement, Mr. W. J. Ruston, chairman of Ruston and Hornsby, Limited, said that their turnover was 10 per cent. higher than in 1953. However, this was due partly to deliveries under the re-armament programme and Mr. Ruston warns that turnover will not be so high this year. Competition is becoming keener, and with rising costs "there is a danger of British capital equipment being priced right out of world markets." In the past, about 85 per cent. of Ruston output has gone abroad as direct or indirect exports: in the past twelve months the proportion has been falling and is now about 70 per cent. Since this Ruston experience is fairly typical of what is happening over a wide sector of British industry, it raises the important question of whether, in view of the continuing drain in foreign exchange reserves, the present high level of industrial prosperity can be maintained. Industry cannot continue indefinitely to supply a buoyant home market without exporting enough to buy raw materials from abroad.

Competition in foreign markets for Diesel engines is perhaps rather keener than for many other products. Mr. Ruston points out that the costs of German manufacturers have risen proportionately less than those of British manufacturers. It is perhaps true also to say that German products have been brought rapidly to the forefront by their technical developments. For example, the Germans have pioneered in air-cooling, and some British companies have found it worth-while to take out licences for the manufacture of German industrial and marine Diesel engines. Equally good work has, of course, been done in the United Kingdom, and Ruston are one of the companies who can take much of the credit. Gas turbines are now a firmly established part of their range, and sales are increasing in applications where their independence of cooling water is an advantage and where their use can be combined with exhaust-heat utilisation for other process purposes. Ruston's subsidiary, Davey, Paxman and Company, have introduced a range of underfloor engines for railcars at the most appropriate time to meet the rapidly rising demand, and Ruston's output of Diesel locomotives, already an important part of their activities, must expand considerably. While the order book is down somewhat (although in Ruston's case still equivalent to ten months' production) and there is room for concern in the export markets, the outlook for British Diesel engine makers is bright enough provided they can keep their technical development and production programmes in line with changing market conditions.

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TEMPERED OPTIMISM

The proceedings at the recent British Electrical Power Convention proved that those engaged in that branch of engineering are in no doubt that the future will show achievements as striking as those in the past. This is not surprising, since both the President in his address and Mr. Eccles in his paper recorded an almost phenomenal increase in the use of electricity for a variety of purposes during the past few years.

Optimism was, however, tempered by the realisation that progress will not be automatic, and that to achieve it a series of problems, both technical and economic, will have to be solved. Of these one of the most fundamental, as noted last week, is that of securing the fuel which will be necessary to generate more than three times the amount of electricity now consumed—a position which Sir Henry Railing considers will be reached within the next 20 years. Coal, it is clear, must continue, in this country at least, to be the principal source of electrical energy, since oil must be imported and water and wind power can make only a small contribution. Nuclear power, although it may well prove an important substitute in the not too distant future, will require a good deal of difficult development work before it can play a prominent part. The prospects of utilising solar radiation are still more remote.

It follows that every effort must be made to achieve greater economies in the use of coal for electrical generation. Fortunately, recent statistics show that progress in this direction is steady and Mr. Eccles gave a valuable account of what is being done by the Central Electricity Authority to accelerate it. Briefly, the methods so far adopted include the simplification of the steam-raising plant, thus improving its availability; the employment of the unit principle of one boiler, one turbine, and the re-introduction of re-heating to promote further economy. For the same reason, steam conditions have taken an upward trend and a pressure of 1,500 lb. per square inch with a temperature of 975 deg. F. and a re-heat temperature of 950 deg. F. is to be utilised on four new 100-MW units and 1,000 deg. F. re-heat on eight 120-MW sets.

Looking still further ahead, units with steam conditions of 2,350 lb. per square inch, a temperature of 1,050 deg. F. at the stop valve and a re-heat temperature of 1,000 deg. F. are being designed; and three of these, with individual outputs of 200 MW, should be installed within the next five years. Even this is not the end. Studies are now being made into the possibilities of using pressures as high as 5,000 lb. per square inch and into various gas turbine cycles. This all opens up the prospect of increasing the average thermal efficiency from the present figure of 24 per cent. to 40 per cent. or even more, and securing a corresponding improvement in the coal consumption.

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SHOCKS FOR INDUSTRY

British industry, scarcely beginning to recover from the setbacks caused by the railway and dock strikes, received further shocks last week.

A series of substantial new demands put forward at the annual delegate conference of the National Union of Mineworkers was followed by the decision of delegates at the annual conference of the National Union of Railwaymen to initiate fresh pay claims, for an unspecified amount, and capped by the announcement of a spectacular advance in coal prices, to become effective as from Monday next. The inland prices of all grades of coal are to be raised by 18 per cent., or an average of 11*s.* 5*d.* a ton, with increases for the household varieties ranging from 7*s.* 11*d.* to 19*s.* 1*d.* a ton, according to quality.

These increases, which are expected to yield £53 million during the coming six months and £118 million in a full year, will not reduce the Board's accumulated deficit (at present standing at more than £17 million), even by the end of next year. Indeed, the deficit is likely to rise by a further £15 million before the end of December and not all of that sum is expected to be made good in 1956, according to the Board's calculations. The present increase of 18 per cent. in the price of coal is the largest to take place since the nationalisation of the industry on January 1, 1947, and compares with an advance of 10 per cent. early in 1953. The Board considers that its financial position is such that, allowing for all practical economies in its operations, the increase is urgently necesssry to bring prospective expenditure and income into proper relationship. It is claimed that the increase has resulted, not so much from narrow financial considerations, as from an appraisement of the basic facts of the industry.

Four main considerations are stated to affect the Board's financial commitments. These comprise the effect on the industry's wage bill of rising wages and prices in the country's general economy; the need to import large quantities of coal from abroad, owing to the increase in home demands; expenditure on the rehabilitation of the industry, which cannot be expected to produce immediate results; and additional expenditure on health schemes and safety precautions. The Board recognises that an increase of this magnitude is bound to be unpleasant and unwelcome, but affirms that, at a time of severe shortage, coal should not be disposed of at less than the cost of production. The Board considers that it would be wrong to keep the price of coal artificially low.

Some indication of the possible effects of the increase on the fuel bills of the main industrial consumer groups is contained in the list of advances in prices announced by the Board. According to this list, average prices per ton will be raised by 12*s.* 5*d.* to railways and gasworks, by 9*s.* 3*d.* for power stations, by from 11*s.* 8*d.* to 12*s.* for coking plants, by 11*s.* 6*d.* for iron and steel undertakings, by 12*s.* 8*d.* and 12*s.* 9*d.* for bunkers, and by 10*s.* 11*d.* for all other industrial sales in Britain. It is provisionally estimated that the total rises in annual fuel bills will amount to over £22 million for private firms, to £8¾ million for the railways, to £20 million for power-supply undertakings, and to £17¾ million in the case of gasworks.

These increases in coal prices take no account of last week's decision by the miners' union to make a number of new claims, each of which, whether granted wholly or in part, would add considerably to the Board's expenditure.

* * *

STANDARDS IN THE MOTOR INDUSTRY

The decision of the Society of Motor Manufacturers and Traders to form a Standards Department as an integral part of the Society will co-ordinate and speed up the work which has so far been done by various technical committees dealing with materials, cars and commercial vehicles, trailers, tyres and wheels. The nucleus of the first Standards Board has been formed under the chairmanship of Mr. E. G. Grinham, deputy managing director of the Standard Motor Company, Limited, and the new department will be managed by Mr. Eric Woodbridge.

Car manufacturers have not found it practicable to adhere to war-time dreams of a one-make one-model programme, but within the big groups there is now a large degree of interchangeability of components. Most of the British Motor Corporation's passenger car requirements are met by three basic engines, and the Standard Vanguard engine has been used in two saloon models, two sports cars, and a tractor besides emerging in a Diesel version. Much has been done by suppliers in reducing the ranges of electrical components, brakes, ball and thin-wall bearings. The range of steel specifications has been simplified, and on an international plane the use of Unified screw threads on the new Rolls-Royce and Bentley cars marks a step forward.

The Society has about 50 standards of its own, covering a variety of subjects—carburetter, fuel pump and distributor mountings, wheels and tyres, coil and leaf springs, piston rings and power take-offs, drain plugs, and driving vision. However, it has not yet proceeded as far as the American industry in this respect. There is no recommendation on bumper height, because this has so far been found impracticable owing to the large differences in vehicle sizes. It is noteworthy also that in two of the subjects most discussed at the present time—headlamp dazzle and flashing indicators—there are no standing recommendations. The requirements here are laid down by regulation after consultation with the Society and, in any case, neither headlamps nor direction indicators are compulsory fittings. Investigations are, however, being carried out with a view to evolving a more satisfactory flashing indicator, although those now in use meet the requirements of other countries where such indicators have been used for ten years.

The new department will work in the closest cooperation with bodies such as the British Standards Institution and the International Standards Organisation. There are, however, matters such as special materials for automotive applications, and safety and performance standards, especially where legislation is involved, where it will have to take the initiative. The policy will be wherever possible to lay down the standards of performance required, leaving designers the maximum freedom in choosing the means to be employed.

One direction in which some standardisation is to be hoped for is in the evaluation of engine horse-power. At present there is little means of knowing what is meant by the figures in the catalogues. Germany and Italy have standards, the D.I.N. and C.U.N.A., which give some uniformity in such matters as engine testing and vehicle road-performance evaluation. A German car manufacturer's horse-power figure represents the power available at the clutch, to drive the car. The Americans, on the other hand, quote according to an S.A.E. standard, giving the power achieved on the test-bed without auxiliaries. On the largest engines in use, the difference may be as much as 25 h.p., and now horse-power figures have become an important sales point in the United States, some German manufacturers have begun in self-defence to quote power according to American standards. In this country, Vauxhall give both versions, but otherwise the buyer is usually left in the dark as to the conditions in which his engine is supposed to give its advertised power.

* * *

ROLLS-ROYCE EXPORT £13 MILLION

If there was a company world prize for outstanding technical progress allied to commercial achievement, Rolls-Royce would be very much in the running. Lord Hives' review of the past year showed that both turnover and profit reached a new record which he describes as " the result of long-term planning helped by a year of relatively stable conditions." The chairman has much to say about the workers' shares scheme and an extension of their pension scheme. The company's progress along the path, so fashionable nowadays, of personnel welfare, compares not unfavourably with that of I.C.I., Courtaulds and, in the United States, the Ford Motor Company, General Motors and other industrial giants.

The trading basis of Rolls-Royce is not always appreciated. Lord Hives reviews the performance of each of the three main divisions: aero-engines, motor cars and oil engines. Aero-engine production has been increased by expanded output in the Scottish group of factories which, with the Derby group, will now meet the company's full requirements for productive capacity. Standard Motors and D. Napier will therefore discontinue making the Avon engine after this year. The success of the Dart engine, still the only propeller turbine in civil airline operation, receives special mention, as does the new and more powerful Avon engine expected to power the Comet Mark IV. A successor to the Dart, the RB109, has started its programme of development running. The motor-car division has sold more cars than ever before, and has begun to manufacture torque converters under licence from the Twin Disc Company of America. The oil engine division is making progress in a highly competitive market, and there is little doubt that the Rolls Diesel engine—which is more in line with American than with British practice—is rapidly gaining ground, despite being dearer than most.

The export performance and the continuing increase in royalties received from licensees are evidence enough that in these fields Rolls-Royce have made British Engineering quite supreme. Even if expenditure on armaments continues to decline the company should more than hold its own in world trade.

* * *

LEYLAND MOTORS IN INDIA

Leyland Motors, Limited, announced last week the formation of a company in India—Ashok-Leyland, Limited,—for the manufacture of commercial vehicles and Diesel engines. In this they have followed what is now fairly general practice by investing a substantial amount (amounting, doubtless, to a controlling interest) in a local company who had operated as their main distributors. A joint board of British and Indian directors has been appointed, as reported on page 70, and initial orders have already been placed for £100,000 worth of machine tools, jigs and other equipment. Ashok Motors, Limited, had since 1950 been receiving chassis in knocked-down condition which they assembled at their factory near Madras. The location is highly convenient for rail and port facilities and the stage is well set for the growth of a large manufacturing unit, with the participation of distinguished Indians on its board, including an Indian chairman.

The growth of manufacture will be gradual, and import of components will be continued until those industries ancillary to motor manufacture have been further developed. The major problem and the cause of so many failures in the past—the supply of trained operatives and supervisory grades—has been tackled with commendable energy. Arrangements are being made for an interchange of personnel between the two companies. Leyland will supply the planners and engineers until a sufficient number of Indian technicians have been trained at the Leyland factories, which now include those of Albion Motors and Scammell Lorries as well as those of the parent company.

The Indian company may develop vehicles specially designed for the Indian market, though at first it will concentrate on the production of the Comet, of which a large number are already in use in India. The market for this type of vehicle is large and growing. Leyland are not alone in the field, and will meet competition—particularly from local German enterprise—but they are in good time to make a fight for it.

TRANSPORT AND ENGINEERING

SUMMER MEETING OF THE I.MECH.E.

The Summer Meeting of the Institution of Mechanical Engineers was held this year at Southampton from July 5 to 8. A very full programme of professional and general interest, supported by social functions during the evenings, had the advantage of glorious weather throughout the week, but the unstinted hospitality of the civic authorities, local industry, both large and small, and the local establishments of the armed services, added to the efforts of the reception committee and the staff of the Institution, ensured success no matter what the weather might have provided. Over 430 members attended and many were accompanied by their ladies.

The professional interest of the meeting centred on four papers—of which brief abstracts are given below—and visits to engineering works in the area. On the Wednesday, members saw the President, Mr. P. L. Jones, M.C., Wh.Ex., unveil a memorial tablet (which is illustrated below) to commemorate the work of the Taylors of Southampton. Fixed to the wall close to the old West Gate of the town, the tablet is near to the cellar where, in the Eighteenth Century, the Taylors had begun their work, the subject of one of the four papers given at the meeting.

SOUTHAMPTON DOCKS

The first of the four papers was given by Mr. R. P. Biddle, C.B.E., Docks and Marine Manager at Southampton. The premier ocean passenger port in Britain, it has the second largest total tonnage of vessels entering, and is among the first six in the value of cargo handled.

After briefly outlining the early history of the port and the development of the docks and the shipping services, Mr. Biddle related how, after 1919, increased traffic had necessitated more dock accommodation. This had been obtained by an ambitious scheme of reclamation which had involved the construction of the New Docks and the establishment of the adjacent trading estates. The King George V dry dock, intended primarily for the 80,000-ton "Queen Mary," had been completed in May, 1933.

Coming right up to recent times, Mr. Biddle described the Ocean Terminal, opened in 1950, as the outstanding feature of the docks and as one of the finest passenger-reception stations in the world. The limited space available had been overcome by designing a double-storey building. The link between ship and shore at first-floor level was provided by electrically-operated telescopic gangways leading directly to the vestibules of the two reception halls on the upper floor—halls which provided every possible convenience for the passengers. The high-level footbridge giving access to the visitors' balcony was one of the first prestressed-concrete structures in Britain.

Imports mainly comprised fruits, vegetables and other foodstuffs, as well as wool, hides, timber and grain. Mechanical aids for handling various bulk cargoes had been fully explored, and the result included quayside electric level-luffing cranes of the latest design together with electrically-operated elevated-platform trucks, used in conjunction with pallets, thus enabling the speedy handling of difficult loads. Though the development of the port had been due in no small way to its favourable geographical situation and the unusual tidal phenomenon which provides high water for about three hours twice in the 24 hours, a significant advantage provided by the Port Authority was the service afforded to ship owners for the maintenance, overhaul and repair of vessels, from the world's largest liners down to the smallest type of harbour craft.

PIONEERS IN PRODUCTION

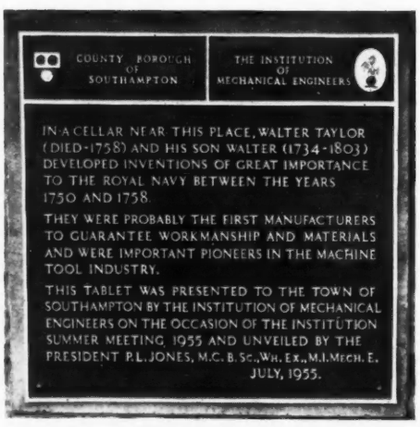
The second paper, to which reference has already been made, was read by Mr. J. P. M. Pannell, M.B.E., and entitled "The Taylors of Southampton: Pioneers in Mechanical Engineering." There were three generations of Walter Taylor; the first, a master builder, died at the beginning of the Eighteenth Century. His son, the second Walter, went to sea after learning his trade as a carpenter and experienced at first hand the perils of sailors exposed to the elements in ships rigged and equipped with inefficient gear. His son, the third Walter, was apprenticed to a maker of ships blocks and on completion of the apprenticeship, father and son combined in an endeavour to improve the manufacture of these blocks. They successfully developed primitive machinery for sawing and boring operations which so improved the quality of the blocks that, between 1760 and 1770, the Admiralty transferred the bulk of their contracts for blocks to the Taylors. In 1770 a disastrous fire at Portsmouth Dockyard destroyed the entire stock of blocks at the port, and the firm were urged to supply replacements as quickly as possible.

To achieve the improvements, the Taylors had jointly or individually invented the circular saw, friction driving in mill gear, and possibly the roller bearing. They had also introduced, in an elementary form, the basic principles of rectilinear alignment and guiding. As well as the blocks, the pumps made by the third Taylor for Royal Navy were a great advance on any previously used for ships. He had experimented with pumps having glass barrels so that the operation of the valves could be observed, and thereby evolved a plunger pump with spherical valves on cylindrical seatings. These cleared themselves more readily than the flap valves used hitherto. Mr. Pannell also traced the connection between the Taylors, Henry Maudslay and Marc Isambard Brunel, and suggested that both Maudslay and Brunel owed much to the basic ideas of the Taylors.

MAINTENANCE OF THE FLEET

From the problems of the Fleet nearly 200 years ago, the members moved forward at a later meeting to the present day. In a paper entitled "The Changing Pattern of Maintenance and Repair of the Machinery of the Fleet," Rear-Admiral John E. Cooke, R.N., traced the alterations in the work of the Chief Engineer's department during the past 40 years and noted the conditions that would dictate future action.

The methods of maintenance and repair—which were defined—were described for each of the periods of the 1914-18 war, between the wars, the 1939-45 war, and the ensuing ten years. The recent lessons of the last war, the advances in processes, equipment, and techniques were stated, thereby noting the changing pattern from the treatment of breakdowns to the prevention of breakdowns. The consciousness of the need for planned "preventive maintenance" and a forecast of how this need was being met concluded the paper. Machinery had been set up for the preparation of preventive-maintenance schedules for various classes of ships, and Class Authorities had been established to keep the schedules up to date, guide the overall effort, and to undertake a number of other duties and services detailed in the paper. Usage-maintenance-repair equations were being established, and concerted Admiralty, Fleet and Dockyard action was being taken to ensure the constant aims of the "highest possible availability" and a "full reservoir of serviceability."


COUNTY BOROUGH OF SOUTHAMPTON
THE INSTITUTION OF MECHANICAL ENGINEERS
IN A CELLAR NEAR THIS PLACE, WALTER TAYLOR (DIED 1758) AND HIS SON WALTER (1734-1803) DEVELOPED INVENTIONS OF GREAT IMPORTANCE TO THE ROYAL NAVY BETWEEN THE YEARS 1750 AND 1758
THEY WERE PROBABLY THE FIRST MANUFACTURERS TO GUARANTEE WORKMANSHIP AND MATERIALS AND WERE IMPORTANT PIONEERS IN THE MACHINE TOOL INDUSTRY.
THIS TABLET WAS PRESENTED TO THE TOWN OF SOUTHAMPTON BY THE INSTITUTION OF MECHANICAL ENGINEERS ON THE OCCASION OF THE INSTITUTION SUMMER MEETING 1955 AND UNVEILED BY THE PRESIDENT P.L. JONES, M.C. B.Sc., WH. EX., M.I.MECH.E. JULY, 1955.

The tablet unveiled by the President of the Institution of Mechanical Engineers during the recent Summer Meeting at Southampton. It commemorates the Taylors, father and son, pioneers in precision production engineering.

The paper was followed by a discussion during which emphasis was laid upon the importance of adequate records of component life and wear. So far as the Royal Navy was concerned, it became clear during the discussion that the submarine service could claim to have introduced such records during the early 1930's. The value of the Spare Parts Distributing Centre and its branches overseas, previously mentioned in the paper, was stressed. The measurement of the success of the Centre was succinctly ascribed to "P.I.P."—the adequate protection, identification and packing of each and all of the parts handled.

FREIGHT AIRCRAFT

The fourth paper, which was presented at an alternative meeting held simultaneously to that considering Admiral Cooke's paper, was entitled "A Review of Freight Aircraft," by Mr. B. P. Leight, now chief designer of Blackburn and General Aircraft, Limited, Brough, E. Yorks.

The author described the engineering problems of such freight-carrying aircraft, emphasising the significance of the uses to which the aircraft would be put. The characteristics of contemporary freight aircraft were described in broad terms, and it was shown how these ranged from high-performance passenger aircraft, designed with little regard to freight handling and stowing, to relatively low-performance aircraft with end-loading fuselages better adapted to receive freight.

After considering the problems involved in designing the aircraft as such, Mr. Leight went on to discuss more generally the freight-handling problem. When the time of loading was not important, simple procedures such as manual stacking from a fork-lift truck were usually practicable if the average parcel size did not exceed 100 lb. A faster method required the plane to be brought into a loading bay equipped with mechanical means for moving the freight. Handling of the separate parcels was avoided by employing complete external pods with internally-fitted pallets. It was true, however, that insufficient attention had been paid to the combined problem of the aircraft and its associated freight-handling equipment.

Since cost was of great importance in the development of civil freighting, the author then dealt with the make-up of the direct operating costs. The cost of each ton-mile included depreciation, insurance, maintenance, crew and fuel costs, and landing fees. Using a specific example, Mr. Leight showed that, since first cost was not of overwhelming significance, all possible reductions in basic weight of the aeroplane were justified even at apparently great increases in initial cost. Throughout the paper, the parallel was drawn between the problems of the civil and military operators. Ways had to be found, however, of reconciling the needs of these two users as otherwise present trends might produce aircraft suitable for only one type of work.

Taking the four papers together, it can be seen that the theme of the meeting was concerned with transport and, fittingly at Southampton, emphasis was laid on the sea. The air was not forgotten, as can be seen from the last-reported paper, and for the railways—even though they were not the subject of a paper—the rolling-stock works at nearby Eastleigh were the venue for one of the excursions by the members.

Letters to the Editor

OPPORTUNITIES FOR YOUNG ENGINEERS

SIR, The leading article in your issue of July 1 is of particular interest to the smaller firms requiring graduates for developing engineering skills and techniques as well as for designing and manufacturing goods which can be sold abroad.

The future of the country depends on selling abroad and we in this country are in a position where the goods we can offer are mainly technical skills rather than raw materials. Young men with initiative, brains and practical commonsense, whether graduates or non-graduates, are the main requirement, but a graduate background is useful to build upon. A difficulty is that many graduates nowadays are, not unnaturally, more concerned with a high starting salary and an exactly regulated future than with the zeal to join firms without so much certainty of the precise salary they will receive in 20 years' time, but with vastly interesting possibilities of rapid advancement if they make the grade.

Yours faithfully,
A. C. VIVIAN, M.I.C.E.,
Managing Director.

Metal and Pipeline Endurance, Limited,
Chandos Court,
Caxton-street, London, S.W.1.
July 6, 1955.

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"THE INQUIRING MIND"

SIR, We were naturally most gratified at the notice you took, in your issue of July 1, of our film "The Inquiring Mind," recently completed for the Institution of Electrical Engineers. We hope, therefore, that you will forgive us if we add a postscript to your notice in the form of a correction.

You attribute the production of "The Inquiring Mind" to Variety Films, Ltd. While the company in question does indeed produce films concerned with a wide range of subjects, we feel we should point out, in the interests of truth, that our associate company is actually registered as Verity Films Ltd. Mr. Oswald Skilbeck, the producer of "The Inquiring Mind" is the managing director of this company.

Yours faithfully,
DUDLEY KNOTT.

The Film Producers Guild,
Guild House,
Upper St. Martin's-lane,
London, W.C.2.
July 4, 1955.

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TORSIONAL VIBRATION IN MARINE PROPELLERS

SIR, In his article "Torsional Vibration Damping Coefficient for Marine Propellers," published in ENGINEERING for May 13, 1955 (vol. 179, page 594), Mr. Archer makes the statement: "In marine propeller shafting systems by far the most efficient device for damping torsional vibrations is the propeller itself." The writer feels that this statement requires qualification.

The propeller damping coefficient K, with which the article is primarily concerned, is used in torsional vibration calculations to determine propeller damping torque. This torque is given by a term $K\,\delta\omega_{(v)}$, where $\delta\omega_{(v)}$ is the small finite change in the angular velocity of the propeller shaft due to torsional vibration. (K is here assumed to be constant over a very small range of $\omega_{(v)}$.) The phase velocity of torsional vibration, v, will normally be a harmonic of $\omega_{(v)}$, i.e., $v = p\,\omega_{(v)}$ where p is an integer. The maximum value of $\delta\omega_{(v)}$ in the above expression for damping torque equals $\theta_m\,v$ where θ_m is the maximum angular amplitude of propeller vibration. Hence the maximum damping torque per cycle is $K\,\theta_m\,p\,\omega_{(v)}$. The energy absorbed by the propeller per cycle of cosinusoidal vibration is therefore

$$K\,\theta_m{}^2\,p\,\omega_{(v)}\,\pi.$$

If propeller damping alone is considered, practical cases arise where a large change in propeller amplitude results from a modal change over a relatively small shaft-speed range. Thus, whereas the propeller may be an efficient dissipater of vibrational energy in one mode, it may be relatively ineffective in another. An example quoted in the writer's article in ENGINEERING for April 1, 1955 (vol. 179, page 404), Fig. 4, in which propeller damping was the only damping considered, shows that relatively it has no influence in the two-node mode. Full scale tests quoted by Heiser[1] and referred to by Yates[2] have shown clearly that the two-node mode is in fact heavily damped. It can only be concluded that internal sources of damping are both real and relatively more effective in this mode than the propeller.

Possibly Mr. Archer means by his statement that in those low frequency modes of practical importance which require checking by calculation, propeller damping is the most efficient device for limiting amplitudes. It is fortunate that its effect is amenable to theoretical treatment. In multi-node modes, the well-established existence and efficiency of internal energy-dissipation fully offsets the ineffectiveness of propeller damping. The great difficulty of calculating internal damping coefficients precisely can be circumvented by estimating a percentage energy dissipation per cycle.

Yours faithfully,
J. P. DUNCAN.

University of Manchester,
Manchester 13.
July 5, 1955.

[1] Heiser, G. H., "Torsional Critical speeds in Geared-Turbine Propulsion Equipment." *Marine Engineering & Shipping Review*, July, 1945.

[2] Yates, H. G., "Prediction and Measurement of Vibration in Marine Geared-Shaft Systems." *Proc. I.Mech.E.*, advance copy dated April 1, 1955.

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Obituary

MR. E. E. HOADLEY, C.B.E.

Electricity Supply

The older generation of electricity supply engineers will learn with regret of the death of Mr. E. E. Hoadley, which occurred at Guestling, Sussex, on Friday, July 8, at the age of 80.

Edward Ernest Hoadley was born at Rochester on October 24, 1874, and was educated at Sir Joseph Williamson's Mathematical School in that town. He received his technical training at Finsbury Technical College under Silvanus Thompson.

After serving a short time with the Chatham, Rochester and District Electric Lighting Company, he was appointed junior assistant engineer in the Electricity Department of the Eastbourne Corporation. From 1895 to 1897 he was a charge engineer at Islington and then became resident, and subsequently chief, electrical engineer to the Barking Corporation. Two years' service as chief assistant engineer at Worcester followed, and in 1901 he became engineer and manager at Maidstone, a position which he held until his retirement a few years ago. During his long tenure of this post he did much to develop electricity supply in the area, especially on the domestic side, and was responsible for the design of the present power station, which now has a capacity of 15 MW.

Mr. Hoadley was appointed a Commander of the Order of the British Empire for his services to electricity supply in 1946. He was elected an Associate of the Institution of Electrical Engineers in 1896, transferred to the class of Associate Members in 1900 and to that of Members two years later. He played a leading part in the affairs of the Incorporated Electrical Municipal Association and served as President in 1934-35. In the latter year he acted as president of a National Electrical Convention which, although *sui generis*, may be considered as the forerunner of those which now take place annually. He was the author of a number of papers on subjects connected with electricity supply.

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MR. E. P. MUNTZ

Civil Engineering in Canada

We also regret to record the death of Mr. E. P. Muntz, which occurred recently at Hamilton, Ontario. He was 62 years of age.

Eric Percival Muntz was born in Toronto on July 21, 1892, but was a member of the well-known Midland family which has for many years been engaged in the manufacture of the alloy which bears his name. He was educated at Upper Canada College and Toronto University; after graduating in 1914 he was engaged on the Canadian National Railway and on the construction of the Welland Ship Canal, of which a detailed description appeared in ENGINEERING in 1929. In 1916 he joined the Canadian Army and served in Palestine.

On returning to Canada he was again for a short time engaged on the Welland Ship Canal, but in 1920 became constructional manager to J. B. Nicholson, Limited, being employed by them in the building of a number of bridges and viaducts. Three years later, however, he set up in practice on his own account and in 1947 was appointed consulting engineer to Hydro-Electric Power Commission of Ontario.

Mr. Muntz had been a member of the Association of Professional Engineers of Canada for many years and served as its president in 1938. He was also a member of the Engineering Institution of Canada, acting as vice-president in 1940. In the same year he was president of the National Consultative Council.

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PROFESSOR G. MAGNEL

The Belgian System of Prestressing Concrete

It is with deep regret that we have learnt of the recent death on Tuesday, July 5, of Professor Gustave Magnel who has given his name to the Magnel-Blaton or Belgian system of prestressing concrete. Full details of this system were published in ENGINEERING for January 13, 1950 (page 54, vol. 169) but it is fitting at this time to describe briefly the principal components.

The system, which was primarily conceived for post tensioning, comprised a rectangular cable made up of a number—perhaps as many as 40—high-tension wires in layers each of four wires, and the "sandwich" end anchorages. The wires, either 0·200 in. or 0·276 in. in diameter, were made to retain their positions throughout the length of the cable by the use of "grills," the number and spacing of the grills being determined by the curvature of the cable. In this way the wires could be accurately tensioned without the frictional losses that had detracted from some other systems of prestressing. The regular spacing between the wires also permitted full grouting to be accomplished after tensioning of the cable had been completed.

The anchorages consisted of the distribution plate used to transfer the cable load to the end of the beam and the sandwich plates and wedges used for holding the stressed wires. Each layer of four wires was laid in pairs in slots of the plates and they were stressed in pairs; after stressing, a wedge was driven between the two wires and this was sufficient to hold the wires when the jacking force was released. Although, as already mentioned, the cables were originally intended for grouting in post-tensioned beams they have also been successfully used externally to the beam section.

Gustave Paul Robert Magnel was born on September 19, 1889, at Esschen in the province of Antwerp and received his technical training at

the University of Ghent between 1907 and 1912. In 1913 he came to London as an assistant engineer, and later as chief engineer, for D. G. Somerville and Company of London, with whom he was engaged on the design and construction of several warehouses. In 1919 he was appointed assistant professor at his own University of Ghent and in 1927 he became professor responsible for structures and, particularly, reinforced concrete.

Apart from his teaching duties at the university, Magnel built up an extensive consulting practice. As early as 1921 he had been responsible for some iron-ore silos at Ougrée-Marihaye, Liége, which were the largest then constructed. Later works included industrial buildings for the Société belge de l'Azole, Liége, the Walnut Lane Bridge in Philadelphia, and, later, many of the prestressed-concrete structures erected in Belgium. At the time of his death he was designing the 2,082-ft. high television tower that is proposed for the Brussels World Fair in 1958.

He was a director of the Pre-Compressed Concrete Engineering Company of Montreal, Canada, and of Stressed Concrete Designs, Limited, London; he was a member of the Institution of Civil Engineers, to which he had been elected in December, 1950, and of the Institution of Structural Engineers. In 1950 he was awarded the Frank P. Brown medal of the Franklin Institute of Philadelphia for his contributions to the study and practice of prestressed concrete.

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MR. F. D. POWER

Mining Engineer in Australia

We have learnt with regret of the recent death, in his home town, Burwood, New South Wales, Australia, of Mr. Frederick Danvers Power, who was a student at the Royal School of Mines, London, some 75 years ago. Mr Power was 94 years of age, having been born at Lee, Kent, now a south-eastern suburb of London, on May 31, 1861. He received his education at Malvern College, and in 1878, on leaving school, studied chemistry in the Public Analyst's office in Swansea. Mr Power entered the Royal School of Mines in 1880 but in the following year left to go to the Royal Mining Academy at Clausthal-am-Harz, Germany, where he stayed until 1884. Some time afterwards he went to the Antipodes where he undertook mining work in various parts of what is now the Australian Commonwealth. He also worked in New Zealand, New Caledonia and studied the phosphate deposits in the Ocean Islands.

In 1902 Mr. Power was appointed P. N. Russell Lecturer in Mining at the University of Sydney, New South Wales, and remained in this capacity for many years. He was a foundation member of the Australasian Institute of Mining and Metallurgy, was elected a vice-president in 1893 and served as President from 1897 until 1904. For a number of years after 1904 Mr. Power was examiner for the New South Wales Mine Manager's Certificate. He was the compiler of a *Pocket-Book for Miners and Metallurgists*, first published in March, 1892, and a fifth edition of which was issued, after revision by Mr. Power, in 1950. He was also the author of other technical works, reports and papers.

For a long period he was a Fellow of the Geological Society, a member of the Institution of Mining and Metallurgy and a member of the American Institute of Mining and Metallurgical Engineers.

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We regret also to record the deaths of:

MR. NORMAN ALFRED YARROW, M.I.N.A., in London, on June 25, in his 64th year. Mr. Yarrow was a son of the late Sir Alfred Yarrow, Bt., F.R.S., and was for many years, until 1946 (when the ownership of the firm was disposed of), President and chairman of Yarrows Ltd., shipbuilders, ship repairers and marine engineers, Esquimalt Harbour, Victoria, British Columbia, a firm associated with Yarrow & Co. Ltd., Glasgow. After undergoing training as an engineer in this country, in the works of D. Napier & Son, Ltd., London, and W. H. Allen, Sons & Co., Ltd., Bedford, Mr. Yarrow went to Canada in 1914.

MR. CHARLES EDWARD BENNETT HALE, at his home in Battersea, on July 1, at the age of 78. From 1912 until his death, he was chief engineer of the Central Hall, Westminster, S.W.1, and had charge of the staff engaged on the maintenance and upkeep of all the electrical, heating, ventilating, pumping and other plant.

MR. J. J. CONLAN, which occurred suddenly at Purley on Wednesday, July 6, at the age of 63. He joined the staff of the British Electrical and Allied Manufacturers' Association in 1915 as assistant to the Director, Mr. D. N. Dunlop, in his capacity as editor of the *Beama Journal*, a post to which Conlan himself succeeded in 1935. He also played a prominent part in organising the electrical section of the Wembley exhibition in 1924 and the first World Power Conference in the same year. His other work included responsibility for producing the many publications of the Association, including a life of Faraday and the *Beama Catalogue*. He acted as secretary of the Beama Publicity Committee from 1945 to 1953.

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PERSONAL

MR BRYAN DONKIN, B.A. (Cantab.), M.I.E.E., has accepted the invitation of the Executive Council of the Association of Supervising Electrical Engineers, 23, Bloomsbury-square, London, W.C.1, to continue in office as President for a further term. The Association's new national chairman is MR. R. F. MATHIESON, Assoc.I.E.E., London manager, Electrical Apparatus Co. Ltd.

CAPTAIN K. H. T. PEARD, C.B.E., A.D.C., A.M.I.E.E., is to be promoted to the rank of Rear Admiral and appointed Director of the Naval Electrical Department in succession to REAR ADMIRAL SIR C. PHILIP CLARKE, K.B.E., C.B., D.S.O., M.I.E.E., M.Brit.I.R.E. The appointment is to take effect on August 17.

AIR VICE-MARSHAL D. V. CARNEGIE, C.B., C.B.E., A.F.C., has been appointed to carry out liaison duties, on behalf of the British Oxygen Co. Ltd., with the Armed Forces and Government departments.

MR. E. S. COX, M.I.Mech.E., M.I.Loco.E., has been appointed mechanical engineer (development) on the British Railways central staff, in which capacity he will act as deputy to the chief mechanical engineer.

MR. R. E. G. WEDDELL, joint managing director of W. G. Allen & Sons (Tipton) Ltd., has been elected President of the Institute of Welding, 2 Buckingham Palace-gardens, Buckingham Palace-road, London, S.W.1, for 1955–56. SIR CHARLES LILLICRAP, K.C.B., M.B.E., D.Sc.(Eng.), a former Director of Naval Construction, has been elected vice-president.

MR. R. J. GLINN, M.I.Mech.E., has retired after 44 years with Babcock & Wilcox Ltd., Babock House, Farringdon-street, London, E.C.4. He has also retired from the board of the Calorizing Corporation, of which he has been a director since 1928.

MR. CHARLES HOWARD has been appointed engineer commodore of the fleet of the British Tanker Co. Ltd., the shipping organisation of the British Petroleum Group.

SIR CHARLES TENNYSON, C.M.G., secretary of the Dunlop Rubber Co. Ltd., from 1928 until 1948, has been awarded the Royal Society of Arts Bicentenary Medal for 1955, in acknowledgement of his services to the promotion of industrial design.

DR. R. C. KING has retired from the board of the Consolidated Pneumatic Tool Co. Ltd., 232 Dawes-road, London, S.W.6, as from July 1. On that date MR. C. L. FISHER was elected to the board.

MR. S. ARCHER, M.Sc.(Durham), M.I.Mech.E., has been promoted from a senior to a principal engineer surveyor on the chief engineer surveyor's staff, headquarters, Lloyd's Register of Shipping, 71 Fenchurch-street, London, E.C.3.

MR. G. A. DICKINS, B.Sc., F.Inst.Pet., has been appointed assistant manager, technical department, London headquarters, Vacuum Oil Co. Ltd. MR. V. H. RUMBLE, B.Sc., has succeeded Mr. Dickins as superintendent of the company's central laboratories, Wandsworth, London, S.W.18, but will also continue to direct the activities of the products division. MR. F. J. PATMAN and MR. P. E. B. VAILE have been appointed assistant supervisors of the products division. MR. T. PATERSON has been transferred from the central laboratories to the headquarters office.

THE HON. MICHAEL LAYTON has joined the staff of the Guest Keen Iron and Steel Co. Ltd., as assistant to the joint managing directors.

New design appointments have been announced by the engine division of the Bristol Aeroplane Co. Ltd., Filton House, Bristol. DR. E. J. WARLOW-DAVIES, B.A., B.Sc., has been appointed deputy chief engineer of the division and a member of the divisional board. MR. S. S. TRESILIAN, B.A.(Cantab.), A.F.R.Ae.S., A.M.I.Mech.E., M.S.A.E., has become an assistant chief engineer and MR. B. S. MASSEY, A.M.I.Mech.E., A.F.R.Ae.S., an assistant chief designer. MR. B. D. BLACKWELL, M.A., B.Sc.(Eng.), A.F.R.Ae.S., has been made engineer-in-charge of a new department for the development of turbine blades.

CAPTAIN E. O. F. PRICE, R.N.(ret.) has been made London area manager of Richard Sutcliffe Ltd., Horbury, Wakefield. The London office is at 235 Vauxhall Bridge-road, S.W.1.

MR. B. EICHLER has been appointed director of research, silica and aluminous division, in the Group's central research laboratories, Worksop, of General Refractories Ltd., Genefax House, Sheffield, 10. MR. H. PARNHAM has been made director of research, basic division, at the laboratories.

MR. J. C. R. BIRNEY has been appointed assistant general manager, David Brown Tractors (Engineering) Ltd. MR. T. A. LAZENBY has been made agricultural sales manager and MR. C. F. WARD, home sales manager. MR. R. W. LADBROOKE, industrial sales manager, will continue to be in charge of sales of industrial tractors and ancillary equipment.

MR. J. F. CONNOR, engineering assistant (mechanical), divisional engineer's department, North Western Division, British Transport Waterways, has been appointed mechanical and electrical engineer, Fleetwood, British Transport Docks.

MR. T. A. DUNCAN, manager, fencing department, Boulton & Paul Ltd., Norwich, for the past 18 years, has resigned and rejoined Croggon & Co. Ltd., structural engineers, 230 Upper Thames-street, E.C.4, as London director.

MR. W. H. MORTON has joined the board of Catton & Co. Ltd., Yorkshire Steel Foundry, 29 Chadwick-street, Black Bull-street, Leeds, 10, as sales director. MR. E. D. WELLS has been appointed technical sales manager.

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COMMERCIAL

LEYLAND MOTORS LTD., Leyland, Lancashire, have announced the formation of a new company for the progressive manufacture, in India, of Leyland vehicles and Diesel engines. The company, ASHOK LEYLAND, LTD., has been formed by the financial reconstruction of ASHOK MOTORS LTD., the Leyland main distributors in India. The chairman is SIR A. RAMASWAMI MUDALIAR, M.P., K.C.S.I., and the other Indian directors are KHAN BAHADUR, C. B. TARAPORVALA, MRS. RAKSHA SARAN, and MR. M. P. SANGHVI. The British directors are SIR HENRY SPURRIER, MR. D. G. STOKES and MR. A. E. L. COLLINS (See editorial comment in Weekly Survey).

WICKMAN LTD., Banner-lane, Tile Hill, Coventry, have concluded arrangements whereby they are the sole representatives in the United Kingdom of two German machine-tool making firms, namely EUMUCO A.-G. FÜR MASCHINENBAU, Leverkusen, and Nagel Maschinen-und Werkzeugfabrik G.m.b.H., Nurtingen/Wurtt.

A new concern, the CONISTON CO. LTD., Eagle House, High-street, Wimbledon, London, S.W.19, has been formed to carry on business as designers of heavy projects and process plants. The chairman and managing director is MR. L. J. SCHWARZ, and the other directors are MR. B. S. BRAILEY, B.Sc., M.I.Mech.E., F.Inst.Pet., MR. N. E. INGLIS, and MR. M. S. BOTTING (secretary).

BABCOCK & WILCOX LTD., the ENGLISH ELECTRIC CO. LTD., and TAYLOR WOODROW LTD., representing respectively steam, electrical and civil engineering, have arranged to operate as a group to undertake complete atomic-power projects of the kind employing gas-cooled, graphite-moderated reactors, like those used at Calder Hall.

W. G. BAGNALL LTD., locomotive builders, Stafford, have entered into an agreement with MORISON AND BEARBY LTD., Newcastle, New South Wales, covering the manufacture, in Australia, of Diesel-mechanical shunting locomotives. The locomotives will be built at Newcastle to Bagnall's standard designs and modified to suit local conditions.

THE BRISTOL AEROPLANE CO. LTD., Filton House, Bristol, have formed a new subsidiary company to take charge of their sales activities in New Zealand. It will be known as the BRISTOL AEROPLANE CO.

(NEW ZEALAND) LTD., and its offices will be in Wellington. The chairman is SIR REGINALD VERDON SMITH, the managing director, AIR COMDRE. G. CARTER, and the other directors, MR. W. MASTERTON, MR. M. O. BARNETT, and MR. J. S. O'LOGHLEN. MR. N. E. HIGGS, formerly the company's agent in New Zealand, will act as consultant.

THE PLESSEY CO., LTD., Ilford, Essex, have formed a separate organisation to handle tool and gauge-manufacturing activities, as from July 1. This, the AMAR TOOL AND GAUGE CO., will continue to function at Chadwell Heath, Essex. A director of the new company, MR. J. R. THOMAS, will be responsible for sales development.

W. & H. NELSON LTD., manufacturers of electrical equipment for mines, Mossend, Lanarkshire, have appointed the BRITISH FLOTTMAN DRILL CO. LTD., Cardiff, to be their agents in the territory covered by the South West Division of the National Coal Board.

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CONTRACTS

230,000-Volt Transformers. The Power Authority of the State of New York has placed an order with the ENGLISH ELECTRIC CO. LTD., Marconi House, Strand, London, W.C.2, for two large transformers to be used in connection with the St. Lawrence Power Project. A hydro-electric power station is now being erected on the St. Lawrence River jointly by the Canadian and United States authorities. For the Canadian side, the English Electric Co. of Canada Ltd. is building, in Toronto, the water turbines to the designs of the English Electric Co. Ltd., of England. On the American side, part of the power generated will be stepped up to 115 kV and part to 230 kV. The transformers which the English Electric Co. are now to build will couple these two 'bus bars together for the interchange of power. They have an output of 120,000 kVA with a voltage ratio of 230/115 kV with the windings auto-connected. A tertiary winding is provided for the supply of power at 13·8 kV. They are three-phase units and the cooling is of the OFW type (pumped oil circulated through water coolers). The main windings will be impulse tested at a level of 900 kV.

Power Station Plant. Orders have been received by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby, through the Australian General Electric (Pty.) Ltd., covering turbo-alternators, transformers, and switchgear for the new Wallerawang power station of the Electricity Commission of New South Wales. Four 30-MW single-cylinder turbo-alternators, with Magnestat voltage regulators, are at present on order and the transformers include four 32·5-MVA, 11/132-kV generator units and two 10-MVA, 132/3·3-kV interconnector units, all with on-load tap changing gear. In addition, five 4-MVA, 11/3·3-kV and eleven 1,000-kVA 3,300/415-volt transformers are being supplied. The switchgear includes eleven 132-kV, 2,500-MVA oil circuit breakers and ten 66-kV, 1,000-MVA-type units.

Cargo Motorship. An order has been placed by the Atlantic Shipping and Trading Co. Ltd. (W. J. Tatem Ltd.,) London, with BARTRAM & SONS LTD., Sunderland, for a 10,000-tons deadweight capacity cargo motorship which is to have a speed of 13½ knots. Her principal dimensions will be 430 ft. by 61 ft. by 37 ft. 9 in. and her draught will be 26 ft. The main propelling machinery will consist of a four-cylinder NORTH-EASTERN MARINE-DOXFORD oil engine, developing 4,400 b.h.p. at 115 r.p.m. The vessel is to be delivered in 1957.

Nuclear Reactor. A contract valued at £750,000 has been placed with HEAD WRIGHTON PROCESSES LTD., Teesdale House, 24-26 Baltic-street, London, E.C.1, for the supply of a 10-MW nuclear reactor to be used [for research purposes in the laboratories of the Australian Atomic Energy Commission, at Lucas Heights, near Sydney.

Electric Cables. British Railways, Eastern Region, announce the placing of a contract with BRITISH INSULATED CALLENDER'S CABLES LTD., for the supply, delivery and erection of pilot cables and pilot route for the Shenfield-Chelmsford-Southend (Victoria) electrification scheme.

Railway Engineering Works. A contract for the construction of three concrete-lined double-line railway tunnels, earthworks, track-laying and ballasting, alterations to Hadley Wood Station, and other works in connection with the widening of the East Coast main line between Greenwood and Potters Bar, on the Eastern Region of British Railways, has been placed with CHARLES BRAND & SON LTD., 25-27 Charles II-street, Haymarket, London, S.W.1.

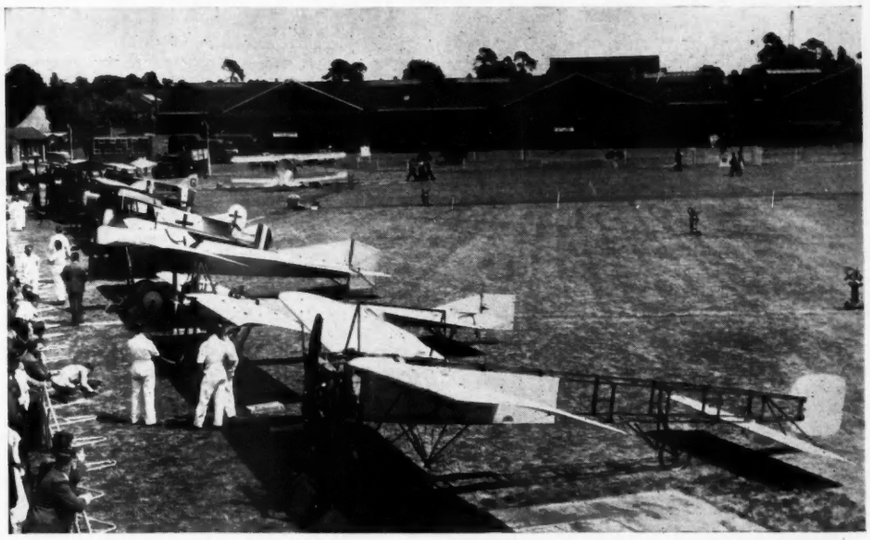

Fig. 1 To commemorate its Golden Jubilee the Royal Aircraft Establishment recently held three open days. The display included a historical exhibition, part of which, including a Bleriot monoplane, is shown here.

FIFTY YEARS AT FARNBOROUGH

GOLDEN JUBILEE OF ROYAL AIRCRAFT ESTABLISHMENT

Few perhaps are aware that the telegraphic address of the Royal Aircraft Establishment is "Ballooning, Farnborough," and possibly as few will know that the R.A.E. owes its origin to the formation of a War Office Balloon Equipment Store at Woolwich in 1878. In 1905 the balloons were first parked on Farnborough Common and it is from this year that the history of the Establishment dates. To commemorate the Golden Jubilee of its foundation, the R.A.E. recently held three open days at Farnborough, and on the first of these, Thursday, July 7, H.R.H. Princess Margaret was among the guests.

The exhibition was in three parts: a historical section (Fig. 1) covering the period 1905 to 1918, which included such veteran aircraft as a 1912 Cody biplane and a 1916 SE5a; a main section entitled "The R.A.E. To-day," in which were shown examples of the Establishment's work, from guided-missile test vehicles to metallurgical research and pilot-ejection seats; and workshop and laboratory departmental displays. Among these were a water tank in which the Britannia aircraft was undergoing fatigue tests, a "cathedral" frame for wing strength testing, supersonic tunnels, the Tridac analogue computer, vibration investigation of aircraft structures, rocket-propelled models, gyroscopic homing controls, beam riding, testing models in free spin by release from a captive balloon (Fig. 2), and the study of kinematic heating. In addition, various aircraft used in experimental work were open to inspection on the airfield apron; some of these were the Boulton and Paul P111A (delta planform), the Short SB5, the Rolls-Royce "Flying Bedstead," (Fig. 1), a Gloster Meteor with jet deflection, a Vampire with wing flow balance, and the Avro 707B. An extensive flying programme included aerobatic displays by ancient and modern aircraft and a fast and slow fly-past of the English Electric P.1. A number of exhibits of special interest are described in this article.

WATER-TANK FATIGUE TEST

The R.A.E. structures department demonstrated the method of fatigue testing an aircraft in a water tank. The fuselage is immersed in water and is also filled with water, the pressure of which can be varied to simulate flight conditions; in addition, the wings, which extend outside the walls of the tank, are supported on hydraulic struts. These raise and lower the wings, so imposing loads corresponding to those on take-off and landing, and those arising from gusts during flight. Two and a half minutes of testing is equivalent to a real flight lasting four hours. By Tuesday, July 5, the Bristol Britannia, which had been undergoing this test, had completed the equivalent of more than 3,000 four-hour flights.

The same department also showed ground resonance and flight flutter testing techniques;

Fig. 2 The Rolls-Royce "Flying Bedstead" vertical take-off aircraft was on view in a section of the exhibition devoted to the work of the "R.A.E. To-day." Overhead, suspended from a captive balloon, can be seen a model used for investigating aircraft behaviour in free spin.

vibrating equipment capable of inducing controlled oscillatory conditions during flight is to be installed in a Hawker Hunter.

HEAT-RADIATION LAMP

At high aircraft speeds, in the region of Mach 3, kinematic heating of aircraft surfaces by air flow presents serious problems, and to simulate heating conditions of this kind during tests on aircraft structures, a 1,000-watt quartz tubular infra-red heater of 5,000 hours normal life can be used. The heater shown was said to be capable of melting by radiation aluminium bars at a distance of 4 in. and incorporated a tungsten filament enclosed in a cylinder of quartz. It was approximately 14 in. long and less than half an inch in diameter, and, in the special conditions of use proposed at the R.A.E., had an output of 3 kW and a shortened life. The makers are Philips Electrical Limited, Century House, Shaftesbury-avenue, London, W.C.2.

The aerodynamics department illustrated a technique known as "telemetry." Hitherto, testing by model in free flight was impracticable; now, however, data can be transmitted from the model during flight to ground receivers by telemetry. Models can be un-powered, and projected up to supersonic speeds by a rocket unit, which falls away when expended owing to its greater air resistance; or powered, and boosted up to speed in the same way.

Among numerous exhibits in the guided-weapons department were shown the test vehicles, G.P.V., R.T.V.1, C.T.V.1 and C.T.V.5, a combined gyroscopic and radar homing device, and wide-angle lens cameras for recording the final motion of an approaching missile from a radio-controlled victim aircraft. Four of these cameras can be placed in the aircraft to cover the complete spherical arc surrounding it, and the viewing angle of each lens is 143 deg. The resulting pictures are distorted but sufficient for practical purposes.

A working model of a friction-controlled gyroscopic homing mechanism, but operated optically instead of by radar, was demonstrated, and illustrated the manner in which a missile can be guided automatically towards a target aircraft. In the full-scale unit the radar system effectively directs the missile towards the target while the gyro-mechanism ensures that the homing "eye" remains on the target during oscillations of the missile itself.

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NUCLEAR POWER AND THE PUBLIC

Exhibition of Programme and Processes

On behalf of the Central Electricity Authority, Trafalgar-buildings, London, S.W.1, a small exhibition outlining the Government's nuclear-power programme and showing in simple terms how the energy of the atomic nucleus is converted into electric power is being held at Charing Cross (Embankment) Underground Station. Entitled "Electricity from Nuclear Power," the exhibition includes an animated model of a nuclear-reactor power station and explains by diagrams the processes involved. The display opened on July 8, and closes on July 26.

Leaflets providing details of "Britain's Programme of Nuclear Power" and briefly describing the technical processes involved may be obtained from the Central Electricity Authority.

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INDEX TO "ENGINEERING"

Volume 178 now ready

The Index to Volume 178 (July-December. 1954) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher, 35 and 36, Bedford-street, London, W.C.2. Any reader wishing to receive regular copies of the Index as they are published can apply to be put on the mailing list. Those already on the mailing list need not re-apply.

ANGLO-AMERICAN CONFERENCE ON AERONAUTICS

HIGH SPEED PROBLEMS, LARGE HELICOPTERS, AND PRESSURE-CABIN FATIGUE

Continued from page 6 (July 1)

A further report from our representative who has been attending the Anglo-American Aeronautical Conference at Los Angeles is given below.

Some of the problems that the Douglas Aircraft Company, Incorporated, have encountered with their high-speed aircraft were described by the chief engineer of the El Segundo division of the company, Mr. E. H. Heinemann, in his paper on "Design of High Speed Aircraft."

Low-lift buffeting had arisen in recent flight tests due to boundary-layer separation, usually caused by the adverse pressure gradient from strong shock waves. It was difficult to predict, but had been overcome by adding fairings and refining abrupt lines. It was a transonic problem and would tend to disappear at supersonic speeds. Buffeting could also be encountered in high-altitude manoeuvres, usually arising from the wing or wing-fuselage combination, but also influenced by the relative position of the tail-plane and the flexibility of the structure. Vortex generators had provided a solution on the A4D Skyhawk light attack aircraft.

Leading-edge slats had solved the problem of longitudinal instability near the stall ("pitch-up"), particularly at landing. They also added a large increment to the maximum lift coefficient. In spite of the disadvantage of complexity and weight, and efforts to obtain a simpler solution, leading edge slats were still used on the three latest Douglas combat aircraft. At high speeds, a point was reached where the slats would not open automatically.

The adverse effect of wing twist on lateral control could be reduced, and control-effectiveness increased by combining a spoiler-type control with conventional ailerons. There had been fears that the deflections of wing, fuselage and tail of swept-back aircraft might reduce longitudinal stability unacceptably, but no such troubles had yet been encountered in flight tests, whereas significant reductions in directional stability had occurred and must be provided for in aircraft designed for high speed at low altitude.

"Dutch roll" lateral-directional instability on high-speed swept-back machines was usually counteracted by yaw dampers, which added weight and complexity. Recently large amounts of yaw or pitch had occurred during rolling manoeuvres, predominantly a gyroscopic phenomenon, which could result in excessive fuselage and fin loads.

At Mach numbers above 1·5, it was difficult to take in engine air at good efficiency without obtaining flow instability. To avoid this, it was necessary to operate the inlet over a narrow range of mass flow by means of variable geometry inlets or similar devices.

Poor flow distribution in the engine inlet could result in premature compressor stall and undesirable engine vibrations. The solution lay in improved air-intake systems and less sensitive engines. Other power-plant problems included duct rumble caused by flow separation ahead of side inlets at low air flows, separation from inlet lips at high angles of attack or low mass flows, and unsymmetric duct flow.

The application of boundary-layer control on the flaps of jet-powered aircraft was now practical, and could result in substantial reductions in landing distances and approach and take-off speeds, but with present engines take-off distances were not improved because of the thrust loss arising from bleeding the compressor air.

Discussing structural materials, Mr. Heinemann pointed out that the actual temperature rise at maximum Mach number would be well below the theoretical since it took time to heat up a large mass of metal. Allowance for this in the structural design would result in a large saving of weight. He mentioned a manganese tool steel, Hy-Tuf, with a strength of 220,000-240,000 lb. per square inch, excellent structural properties and machineability. It was not readily available. Titanium had been used satisfactorily for an explosive bomb ejector where stainless steel had proved to be liable to fatigue failure as a result of inadequate heat resistance.

Discussing the human side of high-speed flight, Mr. Heinemann paid tribute to the medical profession's contributions through improvements in positioning of controls and instruments, in seats and harnesses, and in simplification of controls. Much work had still to be done in the future ranges of speed and altitude.

In conclusion, the lecturer cited data compiled from service experience which demonstrated that for a given reliability in an individual part, the overall reliability of an assembly decreased with increase in the number of parts. The approach to aircraft design should therefore be to keep it light, simple and reliable.

LARGE HELICOPTERS

A new helicopter wing configuration was outlined in the lecture on "Design of Large Helicopters" given by Mr. Bartram Kelley, chief engineer of the Texas division of the Bell Aircraft Corporation.

Mr. Kelley confined himself to shaft-driven helicopters. Discussing limitations to raising the rotor-disc loading, he said that cyclically-varying boundary layer control was being investigated as a means of delaying blade stall and permitting the use of higher lift coefficients.

Up to a gross weight of 4 tons, he considered the single rotor-tail rotor machine the most practical. Above 6 tons, more than one lifting rotor was clearly advantageous. In the interim range, the tandem helicopter was smaller than the equivalent single-rotor machine on account of clearance and centre-of-gravity considerations.

The side-by-side rotor configuration offered the advantages of the tandem machine, without the disadvantage of longitudinal static instability and a higher cruising-power requirement than the single-rotor machine. In fact, the side-by-side rotor machine required less cruising power than the single-rotor helicopter. Control was simplified since the lateral cyclic control was not necessary with side-by-side rotors.

Early side-by-side rotor helicopters had fore-and-aft fuselages and carried the rotors on outriggers on each side. As the design became larger, it would be possible to eliminate the longitudinal fuselage and expend the outriggers to house the engines and passengers. The obvious solution was a wing. Every passenger would have a front seat and an unobstructed view. Whirling-arm tests on models had shown that this arrangement gave a marked reduction in cruising power and fuel consumption and an increase in cruising speed. To gain these advantages, it was important to reduce parasite drag.

The conventional wing was not the only solution for this configuration. A cylindrical fuselage could be adopted, possibly with boundary-layer control, giving the advantage of independence of the wing lift from the wing angle of attack.

PRESSURE CABIN FATIGUE

"Fatigue of Aircraft Pressure Cabins" was

discussed by Dr. P. B. Walker, Royal Aircraft Establishment, who was responsible for the structural investigation of the Comet aircraft after the disasters. In the first part of his paper, Dr. Walker discussed the stress pattern in a pressure cabin. In addition to withstanding the pressure loading, the structure had to resist shear and bending. The pressure shell had therefore to be stabilised by hoops and stringers and, in relation to pressure loads, the structure was redundant. This could have an adverse effect on fatigue, since, at a frame, there was a tendency for the attachment rivets or bolts to pull through the skin. This could easily become a point of initiation of a fatigue crack. Other disadvantages of the structural redundancy arose from the discontinuity at doors and windows of the frames or stringers, and the possibility of an individual bolt or rivet carrying more than its share of load.

Thus frames and stringers appeared to be generally detrimental to fatigue life for pure pressure loading, and their scantlings should be kept to the minimum necessary. There was, however, a school of thought opposed to this reasoning, which held that the main concern was to prevent a crack extending rapidly once fatigue had been initiated. A strong internal structure could limit the rate and extent of crack propagation and so permit repairs before catastrophe occurred.

FATIGUE LOADING

Turning to the applied fatigue loadings, Dr. Walker said that the most important was the main pressure cycle, once per flight, which induced a relatively high stress in a structure designed primarily for static strength. For an ultimate factor of 2 on the pressure loading, the fatigue loading range was 50 per cent. of the ultimate. However, the number of cycles was not likely to exceed 10,000 in the useful life of an aircraft, and the pressure loading was controlled with a degree of precision not to be found in most other loading cases.

The most important additional loading cycle was the transfer of load from the undercarriage to the wings, which produced a change of shear and bending moment in the fuselage. The resulting stress system was complex and aggravated by distortion of the field near doors and windows, and by stress concentrations. The stress range of the lift cycle alone could, moreover, approach two-thirds of that for the pressure cycle for a high-altitude aircraft. The temperature cycle—the change from a hot airfield to the cold upper atmosphere, and back—caused the skin of the cabin to contract against the internal structure, and was opposed to the effect of the increasing differential pressure. In any case, it was unlikely to be significant since tests on the Comet had shown that the temperature difference within the structure was not likely to exceed 10 deg. C. Landing and taxying loads were difficult to assess, but fortunately occurred at zero differential cabin pressure.

In flight, about 20 to 40 gust cycles corresponding to $\pm$ 10 ft. per second might occur. The resulting stresses at critical places were likely to be small compared with the main pressure stresses, but their greater number of applications might be significant, and they might raise the peak stresses as well as producing cumulative fatigue damage.

Fluctuating bending moments on the wings might produce additional loads in the fuselage, aggravated by the necessary rigidity of the attachments and by secondary structures. The loads were difficult to calculate but it was worthwhile reproducing them in a pressure cabin fatigue test.

In the final section of his paper, Dr. Walker discussed the fatigue-testing of pressure cabins. In the R.A.E. tank tests on the Comet, three distinct loading cycles were applied—the cabin pressure cycle, the wing lift cycle, and the wing gust cycle. In the second tank, designed for the Britannia, and suitable for testing a variety of large aircraft, a more complex loading system was employed. Later work on the Comet tank revealed that other-than-pressure loads were more significant than was at first supposed.

In the Britannia tank, therefore, heavy load-carrying members were incorporated in the tank wall, with cross-members above and below the tank. The simple loading points on the Comet fuselage were replaced by lever systems giving more accurate and better distributed loading, and a universal rig applied lateral loads at the fin and rudder. A water storage tank was required, as for the Comet, and this was to be used as a further testing tank for fuselages only. An investigation of the scatter of fatigue life would be made on six Comet fuselages.

Some interesting points arose in the discussion which followed Dr. Walker's lecture; and it was learnt that the National Advisory Committee for Aeronautics (U.S.A.) and the Bristol Aeroplane Company, Limited, were both investigating the possibilities of pressure-cabin structures in which, if a crack should form, it would propagate slowly and non-explosively. The possibility of increasing the life of pressure cabins by submitting every production fuselage to a single preloading in a water pressure tank was suggested, but Dr. Walker pointed out that, while the preload would, if carefully controlled, benefit the structure by redistribution of stress, the difficulty of ensuring that no damage was inflicted by the preload itself was considerable. It would, in any case, be of less value to the well-designed structure than to one with pronounced stress concentrations. The speculation was raised as to whether there was any analogy between the explosive type of fatigue failure in pressure cabins and the brittle fractures that had occurred in Liberty ships.

To be continued

Book Reviews

THE RIGHT WAY IN DESIGNING GEARS

Practical Gear Design. By DARLE W. DUDLEY. *McGraw-Hill Book Company, Incorporated,* 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (7 dols.); and *McGraw-Hill Publishing Company, Limited,* 95 *Farringdon-street, London, E.C.*4. (50*s.*)

The author of this book, Mr. D. W. Dudley, is Supervisor of Gear Advance and Development Engineering of the General Electric Company of America: he has produced a book packed with factual information which will interest his fellow experts, but which will be of real value to the general engineer who needs to come to grips for the first time with gearing problems. Since this is the object of the book, a reviewer may be excused if he considers briefly the formidable problem facing the designer who wishes to learn something of the fundamentals of gearing and to relate practice to theory.

The first thing that will strike our hypothetical designer, who is already an experienced graduate engineer (Mr. Dudley's target is the "practical" man), is the way in which the pundits disagree both on fact and also on how, if at all, the facts may be related to theory, and he will consequently start to try to think out the problems for himself. As a starting point he may well read Steed's little book, *Involute Gears*, but even better he will start with Earle Buckingham's unsurpassed classic, *Spur Gears*, which in its German translation by Olah has been the great formative influence behind European developments. Buckingham's later works have unfortunately lost the splendid clarity and grasp of essentials displayed here. Our designer will also read Merritt's book, *Gears*, which again shows a magnificent mastery of the subject as understood 16 years ago, but which, due to its very appearance of completeness, has tended to stultify further thought in this country. No better book to supplement these works from the practical side could be found than Mr. Dudley's.

One of its great virtues is the way in which it classifies clearly many of the various topics which so often are lumped together in discussions on gear design, and hence it will serve to illuminate other more theoretical works. Mr. Dudley has little concern with theoretical considerations, and when he puts forward a hypothesis he usually makes very clear what are its limitations. In view of this textual accuracy it is a great pity that the three pages devoted to photographs of different types of gear failure are almost valueless due to extremely bad reproduction.

If, on the one hand, this book deals admirably with tooth failure, on the other hand its treatment of this subject reveals very sharply one of the greatest weaknesses in many of the papers on gearing subjects which have appeared recently in this country and in America. Reading of the text and also of the excellent list of references at the end of each chapter shows no knowledge of the thorough, and sometimes brilliant, work of Professor G. Niemann and his school which has appeared in a series of articles in the *V.D.I.Z.* over the past six years. Their series of investigations, both theoretical and practical, into what occurs between gear teeth during the engagement cycle throws light on many of the problems about which conflicting opinions exist. To quote only one instance, whereas Dudley maintains that pitting normally commences on the pitch line, Niemann and Glaubitz have shown that in fact it normally commences on two lines, on each side of the pitch line, where only one pair of teeth is in contact. Our designer, therefore, will be well advised to search through the *V.D.I.Z.* of recent years and also to read Hofer's papers of an earlier period.

Mr. Dudley's discussion of gear materials is informative but not very critical, while his chapter on gear manufacturing methods, though excellent, suffers from being written from an American point of view, and therefore makes no mention of British gear cutting and grinding machinery. The chapter on the design of cutters is adequate, and the only major gap in the whole book is the lack of any serious discussion of the methods available for checking the accuracy of teeth, the relative merits of the various methods available and the difficulties to be met with in this vital problem. In short, this book should find its way into every works library, even if its price puts it beyond the pocket of the individual.

TELEVISION STATIONS

TV Stations: A Guide for Architects, Engineers and Management. By WALTER J. DUSCHINSKY. *Reinhold Publishing Corporation,* 430 *Park-avenue, New York* 22, *N.Y., U.S.A.* (12 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (96*s.*)

The growth of television broadcasting in this country has up to now been largely a story of ingenuity, adaptation and compromise. Technical equipment, although some of the best in the world, has sometimes borne limitations at the time of going into service, and has certainly been improved, modified and enlarged over the years, while the buildings to provide studios and other services have normally been converted from some former use—to mention as examples only Alexandra Palace and Lime Grove. Likewise, the scale and scope of the service offered by the B.B.C.—hitherto the only responsible authority—have grown since 1936, both in the number and location of studios (e.g., now six or more in different parts of London—others in the provinces) and outside broadcasts (eightfold increase in ten years) as well as in the number of

transmitting stations, which are now to be found in nearly all parts of the United Kingdom.

Even though some large extensions are now being planned—for example, the new Television Centre at White City which will be purpose-built from the outset—the B.B.C's television service as a whole will always bear the stamp of an evolved and adapted organisation rather than something spontaneously created. This feature is not unique to British television and much the same story could be told of television in the U.S.A., particularly in New York where the services (several in this case) were developed, except that in that capacious country there has been room for many small independent organisations—each perhaps only serving one city—in addition to the main and well-known networks and companies. Such organisations have been able to take advantage of earlier developments and to plan and construct their " stations " as a whole and in conformity with the latest ideas and principles. For them, in particular, and all those entering the television field, it would seem that Mr. W. J. Duschinsky has directed his advice in *TV Stations*. Whether by coincidence or not, it also happens that in Great Britain a number of freshly-fledged organisations are about to build new television systems, or parts of systems, and to them, more perhaps than to the half-grown and unorthodox (that is, by Mr. Duschinsky's tidy and slightly idealised standards) B.B.C. much that he has written may prove of singular interest and value. One could wish the title to be a little more revealing, as the word " Station " associated with radio or television in this country usually denotes a *transmitting* point simply and solely, whereas Mr. Duschinsky covers the whole gamut of the broadcasting process, and indeed with particular emphasis on the studio side from both technical and non-technical aspects. His book is a masterpiece of compilation and presentation: it is a pleasure to peruse a work so beautifully arranged and illustrated and to discover the subject so thoroughly exposed.

Mr. Duschinsky sets out to examine every component of a television service with considerable emphasis on the economic and organisational aspects on which the commercial success must largely depend. Here again, of course, he is addressing the American companies whose revenue is derived solely from advertising, but their counterparts are now appearing in this country and much that he says may equally apply to them. In this brief space it is difficult to convey the range and detail of the book; it would be even more difficult to point to any feature—from the camera to the transmitting aerial, from the preliminary planning to final buildings, from initial investment to ultimate profits—that has not been covered. Moreover, there is nothing so purely American, either in outlook or in the more technical details, as to prevent ready understanding and application in this country; indeed, Mr. Duschinsky even illustrates with some pictures of B.B.C. studios and technical equipment. All planners of television broadcasting systems, or, as is more likely in this country, of specialised parts of a system—such as studios, film units, networks, transmitters, etc.—can learn much from this remarkably comprehensive and up-to-date book for which one can recall no parallel.

THE BEGINNINGS OF TECHNOLOGY

A History of Technology. Vol. I: From Early Times to the Fall of Ancient Empires. Edited by CHARLES SINGER, E. J. HOLMYARD and A. R. HALL. *Oxford University Press (Geoffrey Cumberlege), Amen House, Warwick-square, London, E.C.*4. (147*s.*)

There have been few books published in this country in recent years, and fewer in the field of technology, to which the description of *magnum opus* can be unequivocally applied, but this monumental work certainly comes into that distinguished category. Indeed, in the magnitude of its conception it is not unworthy to be compared with Henry Thomas Buckle's *History of Civilisation in England*, that massive fragment of a vastly greater project which was all that its author lived to complete. There, however, the similarity ends, for there is here nothing of the rather turgid and often questionable philosophy of Buckle, of whom it was complained by a critical and penetrating biographer that his intellect, while comprehensive and vigorous, was not scientifically disciplined, and that he was unaware where his knowledge ceased and his ignorance began. On the contrary the authors and editors of the present work have not only the advantage of coming into the field a century later than Buckle—a century which has brought an enormous expansion of archaeological knowledge, and of the development of the arts and crafts of ancient civilisations—but the possibly greater advantage of a combined skill and experience in applying scientific and technical resources to the study of antiquities that would be difficult to parallel. The result of their collaboration is a book of which to be proud.

The main purpose of the work, *vide* the preface, is " to provide students of technology and applied science with some humane and historical background for their studies " so that " they may be helped to realise that the subjects of their special training are parts of a very ancient process and are rooted in many civilisations." It does not attempt, however, to portray the development of civilisation in the manner that Buckle envisaged, but concentrates upon only one aspect; it is, in brief, " a history of how things have been done or made," with no more reference to political and economic history than is necessary to maintain some sense of perspective. This first volume carries the story to a period *circa* 500 B.C. The next will deal with " The Civilisations of Greece and Rome, with their *sequelae* in the Middle Ages," i.e., from 500 B.C. to A.D. 1500. In Vol. III comes " The First Impact of Science on Technology," taking the narrative on to *c.* 1700; Vol. IV will deal with " The Beginnings of the Industrial Revolution," *c.* 1700-89; and Vol. V will conclude the work by surveying " The Nineteenth Century."

The time has long passed when such an undertaking could have been financed from the private resources of individuals or even, it may be, the resources of a University Press—at least, in this country; but, just as it was not unknown for the Victorian captains of industry to expend large sums in public beneficence, for which they have not always received due credit in retrospect, so industry has once again come to the aid of scholarship, the necessary financial backing having been provided in the present instance by Imperial Chemical Industries, Limited. Their chairman and directors have done so, it is stated simply, " as a contribution to technical education," evincing thereby a breadth of vision which may not be so rare as is commonly supposed, but which has seldom taken so practical a form. It is regrettable, but inevitable, that a work on such a scale, even when heavily subsidised, should be beyond the means of many who would be glad to possess it and who would profit by the possession; but the fact of its existence will materially help future " labourers in the vineyard " (to use a favourite expression of the late Dr. H. W. Dickinson, whose advice and help in its planning are described by the editors as " fundamental ") and it is to be hoped that no considerations of so-called economy will be allowed to stand in the way of its acquisition by every reference library, public or private, that claims to cater for the technical and scientific inquirer.

The present volume is divided into seven sections, dealing, respectively, with " Basic Social Factors " such as the evolution of skills, early forms of society (conducing to the development of skills), discovery and invention, speech and language, and primitive time-reckoning; " The Food-Collecting Stage," and the arts by which it was recorded contemporaneously; " Domestic Activities," which include the application of rotary motion, the making of fire, chemical- and culinary arts, and the evolution of building techniques in primitive communities; " Specialising Industries," such as pottery and water supply; " Utilisation of Metals " in mining, metalworking, woodworking, etc.; " Transport " by land and water; and " The Preparation for Science " by way of recording and writing, the institution of weights and measures, and the evolution of mathematics and astronomy. Each of these subsections is the work of an expert, and the manner in which they have been brought into conformity with each other and with the main objective commands admiration. The editors have indeed deserved well of their readers. The sense of a realised common purpose is enhanced by the excellence of the illustrations, practically the whole of which have been specially prepared, and with the most consummate artistry.

This much might be said, however, of almost any book designed to appeal to a limited public of connoisseurs, whereas *A History of Technology* is expressly addressed to those who are not connoisseurs, whatever may happen to them in later years as a result of studying it. To appreciate its mind-stirring properties it must be perused in detail, for only thus is it possible to grasp the true significance of its comparative method and to realise with what skill its innumerable facts have been marshalled and correlated. Occasionally there is discernible a tendency to treat an assumption as a fact—or so it would seem, for it may be that, in some instances, this criticism might itself be criticised on precisely similar grounds; but for the most part, by far the most part, the conclusions are supported by such a wealth of evidence as to be unassailable. Certainly, in a reasonably careful reading, no instance was found that could be assailed on any technical grounds; additional proof, if proof be needed, that the character of the intended readership has been kept constantly in mind. After all, some latitude in deduction, some admission of the probability of a link where no actual link exists, must be allowed to the investigator, especially the investigator of pre-history, when the eventual evolution of a process or device is self-evident, and amply demonstrated; for example, in the relation between the invention of the bow and that of the rotary drill.

" Some books are to be tasted," wrote Bacon, " others to be swallowed, and some few to be chewed and digested." Obviously, those which are chewed and digested must first have been tasted, and an appetite stimulated by the tasting. It is more than usually difficult to indicate particular items for tasting where there is food for such a diversity of palates, but, as an instance of how far craftsmanship in metals had developed centuries before the Christian era, there could be nothing more impressive than the Etruscan gold bowl of 600 B.C. illustrated—full size, as it is only 4¼ in. in diameter—in the chapter on " Fine Metal-Work." The decoration is granular, the patterns consisting of fine grains of gold soldered to the background. Each grain measures $\frac{1}{60}$ in. in diameter, and there are more than 137,000 of them. As the authors of the chapter comment, " A glance at a piece of modern jewelry will indicate the distance that separates us from such works as this technical triumph "; and those whose interest is chiefly in techniques may well pause to consider what practical problems that Etruscan craftsman had overcome with such complete certainty 25 centuries ago.

The book is full of such examples. Not all are so thought-provoking as the little Etruscan bowl, but none is redundant. Some are on art plates at the end of the book, one—a splendid reproduction of the lid of the inmost coffin of Tutankhamen—forms the frontispiece; but the great majority are inserted in the text, in proximity to the passages in which they are mentioned. They number 570 and the annotated list of them occupies 25 pages; for the source of each is given, and, very properly, the name of the artist responsible for the reproduction. That is only one measure of the thoroughness which characterises the book. It was nobly planned, and handsomely has it been executed.

British Electrical Power Convention (concluded from page 44)

PRODUCTIVITY, CAREERS IN INDUSTRY, AND FUTURE NEEDS

Opening the discussion on Mr. Eccles' paper, of which we gave an account on page 43 *ante*, Sir Claude Gibb emphasised the duty of driving home the relationship between the use of electricity and productivity; and also between productivity and national living standards. This relationship was not fully accepted in Britain by governments, executives or workpeople, owing to prejudice and refusal to study the available data. If, however, the potential improvements in living standards were appreciated, Mr. Eccles' forecasts would be shot to pieces and the load shedding of past years would be as nothing to that of the future owing to the shortage of coal for electrical generation that would result.

Statistics, which showed a doubling of demand every seven years, would be rendered nugatory in 1956-57 when the horse-power which was being built into new machine tools would be about double that now in use. Many British machine tool makers were, however, still not sufficiently electric power conscious, although to put more power into a machine was always a good investment, provided the operator used it fully.

The paper demonstrated the falsity of accusations of technical backwardness against the Central Electricity Authority which had been made in certain financial journals by a theoretical thermodynamicist who would benefit by a course in elementary economics and by a little experience in operating an electricity supply system. Manufacturers had no quarrel with the technical policy of the Authority. They might, however, disagree with the forecast of the rate of growth of demand and deplore the absence of tariffs which would improve load factors. They would urge a reconsideration of tariff rates and methods of building-up off-peak loads. This would enable the 120-MW reheat units to be operated continuously at maximum efficiency and with minimum maintenance and so make the best use of them.

NUCLEAR POWER ESSENTIAL

Any increase in living standards must be dependent on increased electricity consumption, which would not be possible if it were dependent on coal. Nuclear power would therefore be forced upon Britain at a greater rate than was technically desirable, as it was the only alternative fuel which could be purchased without hard currency. Security had prevented an appreciation of the work which had been done by Sir John Cockcroft, Sir Christopher Hinton and their staffs, but their part in the future of the electricity supply industry would become evident when the failure of the coal industry to meet demands forced the cessation of building coal-fired stations.

He had only one complaint against the paper. It was not sufficiently electrically-minded or sufficiently optimistic.

Mr. W. N. C. Clinch, while proud of the fact that this country was building 200-MW turbines with a pressure of 2,350 lb. per square inch, suggested that super-critical pressures should be considered as these might permit the efficiency to be raised from 37·6 to 43 per cent., which would be a considerable gain.

Mr. L. S. Robson said that the need for turbines suitable for two-shift operation emphasised the importance of easy starting. In this connection the joint investigations of the turbine and boiler makers, with the co-operation of the station authorities, had proved of great value. With unit installations the weight of the steam piping and valves would be reduced by more than 50 per cent. and this, along with close coupling, would simplify the problem of starting that now existed.

Mr. W. B. Shannon suggested that the imposition of conventionally fired plant on the nuclear cycle, thus adding superheat to the steam, offered greater gains than a similar fuel expenditure on the "super" steam cycle with fewer complications.

Mr. Eccles, in reply, said that while at the moment they could obtain the heat equivalent of 10,000 tons of coal from one ton of uranium he hoped to see one ton of uranium becoming equivalent to 100,000 tons or even 1,000,000 tons of coal. Fuel costs would thus be of descending magnitude in the economy of electricity supply. He expressed his appreciation of the co-operation the Central Electricity Authority had received from the manufacturers. He hoped that the new atmosphere which had thus been created would long continue.

The film, "The Inquiring Mind," which has been prepared by the Institution of Electrical Engineers to outline the opportunities for a career in electrical engineering, was then shown. As noted on page 4, *ante*, where a brief review is given, it is to be lent to schools and other organisations for exhibition to audiences who are likely to be interested in a professional career in electrical engineering. Particulars may be obtained from the Institution of Electrical Engineers, Savoy-place, London, W.C.2.

THE SUPPLY INDUSTRY AS A CAREER

The meeting on Wednesday afternoon, June 29, was occupied with a consideration of three papers on "The Electrical Industry as a Career." In the first of these Sir Henry Self dealt with "The Electricity Supply Industry" which, he said, must expand and develop technically. The essence of the industry's work was providing a service to the consumer, and its employees exercised a wide range of skills, both mental and practical. While it was predominantly engineering in character it also called for men and women of other professions. To meet the expanding programme it was clear that the present rate of recruitment on the technical side would have to be increased, and that the training of existing employees to fill posts of greater responsibility would have to be expanded in order to keep pace.

Looking to the future, the aim of managerial training must be to provide the industry with a pool of men from which a selection could be made for all the various levels of management. There should be no limitation of the channels through which future managers were recruited, although clearly the bulk of the appointments called for engineering qualifications. More must, however, be done towards the development of higher managerial experience and ability; training courses, of which details were given, had already been organised from the top downwards on an experimental basis. There was clearly also a need for the future leaders of industry to be picked out at the right stage of their careers. It might bring out all the potentialities in an individual if, in the early forties, he were given a sabbatical year to make what he would of it and to see what would be the effect on his return. There might thus be not merely a heightening of the process of self-development and capacity for leadership, but an indication whether those qualities really existed and could be developed.

Work must be the central strand by which men made their lives whole, but it was not enough. Without width of outlook and breadth of life no man was capable of realising his own possibilities, still less those of others. The cultural side of management must therefore first include full training in human relations. It was thus the over-riding need of the industry to provide facilities for the self-balancing of the individual in equal step with the emphasis on technological training.

THE MANUFACTURING INDUSTRY

Dealing with "The Manufacturing Industry," Mr. S. E. Goodall said that this now employed well over 600,000 persons, whereas in 1925 the number was approximately one quarter that figure. The range of products, both in development and manufacture, continued to grow rapidly, but there was a danger that further progress might be hampered by shortages of trained scientists, engineers and technicians. A wide variety of function, interest and opportunity, however, existed within the industry, and almost any type of person with almost any type of interest could find interesting and progressive employment within it.

One of the primary reasons for the success and growth of the electrical industry were the training facilities provided. The three main courses were those for the craft apprentice, the student apprentice and the graduate apprentice. An outline was given of the ground covered by each, emphasis being laid on the fact that great trouble was taken to ensure that the individual received the training best suited to his needs. Although a great deal of thought had been expended on the provision of adequate academic courses for professional engineers, it was not until comparatively recently that a proper study of the needs of technicians had been made. This was regrettable because a larger proportion of these men were engaged than professional engineers. This defect was now being remedied as was shown by the fact that in 1954 more than 3,000 Ordinary National Certificates and more than 2,000 Higher National Certificates had been awarded in electrical engineering alone, which was a considerable increase.

As regards the next few years craftsmen would continue to be recruited from the secondary and modern technical schools and would follow one or other of the City and Guilds courses, concurrently with practical training. Technicians would be recruited from all types of school and would take during the first year a new basic course which was being developed for them. The needs of would-be professional engineers would be met by the Higher National Certificate Scheme and there would also, it was hoped, be provision for a new type of sandwich diploma course. The objective was to provide the maximum possible degree of flexibility so that the student had opportunities to play his part in the industry, determined only by his natural aptitude and his willingness to work. The main stream of professional engineers would, of course, continue to be educated at the universities, it being now agreed that this form of education could not be bettered, particularly for those who were likely to be charged with administrative responsibility in later life.

THE PROBLEM OF NUMBERS

The difficulty of obtaining an adequate supply of technically or scientifically-minded young men for the industry was now becoming acute; and there was every sign that it was likely to become worse. Steps were being taken to awaken the interest of headmasters and careers masters in public schools, but among the most important difficulties to be overcome was the shortage of science teachers. Another drawback was that some masters regarded engineering as a means of placing problem children. There were, however, enough problem children already in the industry; and what was being sought was a fairer proportion of the best and average brains. There was no doubt that, if the attempt to increase this proportion achieved success, the young men offered would not at first come up to the entry standards required by present academic courses. It was here therefore that the technical colleges might be able to help by providing special "conversion" courses designed to correct any mathematical or scientific deficiencies.

Mere increase in numbers would not, however, be of any lasting value. It was essential that the young man in the electrical industry

should be well educated in the widest sense and well equipped technically to meet the ever increasing demands. No alleviation in standards should be expected. Indeed it was in the best interests of the young men themselves that those standards should be maintained, so that in later years they might feel no lack of confidence in facing up to their responsibilities.

THE SCOPE IN CONTRACTING

The third paper, on "The Installation Contracting Industry," was presented by Mr. R. A. Marryat who said that the supply, manufacturing and contracting industries formed three separate links in the chain of electrical service to the user. The contractor had a special responsibility since his work brought him into the closest contact with the consumer. It was therefore his duty to make sure that the equipment and installation work met immediate needs and could be extended to comply with future demands. He must also ensure that the standard of materials and workmanship throughout the installation provided the best possible protection against fire or shock.

There was infinite variety in the work undertaken by installation contractors, and ample scope for any young man to build up a full and satisfying career. The personnel of the industry was recruited mostly from apprentices who were given a practical training which should be supplemented by technical courses. After completing his National Service the young man returned as a fully qualified journeyman electrician and was engaged on a great variety of jobs, each with its problems and with different conditions to be satisfied. Exceptional facilities existed for promotion.

The work of the installation contractor was equally varied including, as it did, planning, drawing office activities, the preparation of estimates, supervision of work in progress, inspection and testing, maintenance and repairs, accounting and other clerical work and general management. The industry probably offered greater scope for those with the true spirit of free enterprise than any other branch of engineering. Human relations entered very much into the management of day-to-day business, while for the technically minded there was a limitless field for experiment and development in new techniques.

The future would bring continuing expansion of the industry together with a general improvement in standards of design and workmanship, better organisation of individual firms and improved service to the general public. There would also be a rapidly increasing demand for good quality electrical installation work in many countries overseas.

INTERDEPENDENCE AND COMPETITION

Opening the joint discussion on these three educational papers, Mr. A. M. F. Palmer pointed out that the Central Electricity Authority and the Area Boards were under an obligation to consult their employees on education and training. This obligation was being fulfilled both in the letter and the spirit, so that employees felt an increasing confidence in the policy. It was natural that the best brains should be attracted to the manufacturing industry, but they were not on that account lost to supply, because of the interdependence of the two. Competition was likely to have a stimulating effect on salary levels. The engineering industry was now much clearer on the educational structure it needed for the provision of engineers and technologists, and it should be possible to fit the framework of the new legislation foreshadowed in the Queen's Speech round developments which had already taken place.

Mr. E. A. Logan said that competition had been useful in focusing attention on the student apprentice problem at the grammar school level. During the next few years the intake would probably be stepped up. It did not seem possible to fill the top posts in the industry by men working their way up from the bottom, and some system for the injection of ability at intermediate levels should therefore be adopted.

Mr. G. M. H. Houston argued that the basis of all training was the mind. It was therefore essential to aid the student in every possible way, taking account not only of his reasoning faculties, but of his sub-conscious creative and intuitive qualities.

A SHORTAGE OF ENGINEERS

Dr. Willis Jackson pointed out that the shortage of young men for training as engineers was not confined to electrical engineering. In 1953, there had been 300 unfilled first year places in the engineering schools, and in the present session there were over 170. In the next three or four years, 1,500 additional places would be provided, which meant that, over and above the present number of recruits, some 600 to 700 boys of university quality would be required. Similar developments had taken place inside the technical colleges, though here the position was more encouraging. To obtain the extra recruits something should be done to keep at school boys capable of taking the General Certificate of Education at advanced level. There should also be a change in the distribution between science and arts of boys in the sixth form. At present 55 per cent. were on the science side and 45 per cent. on the arts side; and there seemed little hope of a greater number of outstanding entrants into engineering and science unless this proportion could be altered.

Mr. H. W. Swann agreed that the installation contractor had both a technical and moral responsibility not to exploit the customer's lack of knowledge. It should be recognised that installation work required just as much knowledge, initiative and enterprise as supply or radio work. The young installation engineer should enjoy the same status and be able to look forward to a career with as much confidence as his colleagues in other branches of the industry.

The three authors replied briefly.

ELECTRICITY AND THE IRON AND STEEL INDUSTRY

At the meetings on the morning and in the afternoon of Thursday, June 30, four papers were presented on the general subject of "Electricity and the Industrial Future."

The first of these was on "The Use of Electricity in the Steel Industry," by Mr. W. F. Cartwright, the purpose of which was to study the way in which that industry affected the national electrical generating industry now; and how it would affect it in five and ten years. It was assumed that steel production in 1960 would amount to 23·75 million and in 1965 to 26·8 million ingot tons. By 1960 the majority of this production would take place in integrated works and therefore blast-furnace gas would be used where possible for heating the coke ovens and mill furnaces, the remainder being allocated to power generation. The amount of blast-furnace gas available depended primarily on the coke consumed and this, in turn, depended on the pig-iron production.

It was estimated that the pig iron produced in 1960 would be 16·9 million tons and 19·2 million tons in 1965. The total blast-furnace gas produced would be 2,266,350 million cub. ft. in 1960 and 2,366,400 million cub. ft. in 1965. Of these totals, 6·1 per cent. would be available for generating 911 million kilowatt-hours in the former and 1,036 million kWh in the latter year. In addition, 950 million and 1,110 million kWh, respectively, would be generated from coal and oil, giving a total generation within the industry of 1,861 million kilowatt-hours in 1960 and of 2,146 million kilowatt-hours in 1965. The total power consumed in the industry would be 6,969 million kilowatt-hours in 1960 and 8,358 million kilowatt-hours in 1965, leaving 5,108 million kilowatt-hours and 6,212 million kilowatt-hours to be supplied by the Central Electricity Authority.

FUEL BALANCE ALTERED

The section of the steel industry which most affected the electrical industry was rolling and processing. This was due to the replacement of steam-driven sheet and tin mills by wide-strip and cold-reduction mills: the consumption of a cold-reduction mill being extremely high. In 20 years time, too, when the cost of nuclear power might have dropped considerably; when coking coal might have become expensive and in short supply; and when the world's resources of fuel oil might be running low, electricity would play a far larger part in the manufacture of steel in Great Britain than it had done hitherto. In many countries where hydro-electric power was available it was already being used to replace the normal coke blast furnaces. The introduction of electric smelting plant would considerably alter the fuel balance in an iron and steel works, and it was possible that under such conditions electrically-heated soaking pits and annealing furnaces would supersede gas/oil-fired equipment.

Comparing the annual fuel and electricity requirements of an "orthodox" and an "all-electric" iron and steel works, it would seem that the former would have an annual electrical consumption of 848 million units, 127 million units of which would be obtained from the works plant; the overall maximum demand being 138 MW. In the latter, the overall annual consumption would be 5,157 million units, all of which would be obtained from the Central Electricity Authority, the maximum demand being 648 MW.

A PEAK-LOAD PROBLEM

Opening the discussion, Mr. J. F. Smith criticised the author's statement that the use of relatively small boilers in the iron and steel industry would continue in order to limit the maximum demand. The example given in the paper should have caused no embarrassment to the supply industry and there was no need for strict adherence to the "off" and "on" peak hours stipulated in any agreement, if, in emergency, the Board could supply the extra energy without financial loss. It would serve the interests of both industries to widen the peak-load hours as much as possible.

The President emphasised the need for closer co-operation between the supply, manufacturing and steel industries. The figures given by Mr. Cartwright of future demands were of great interest and similar figures for other industries would be helpful to the Central Electricity Authority in making their forecasts.

The author, in reply, said that the steel industry would always need to do a certain amount of generation to guard against external breakdowns. This was irrespective of the maximum demand. It was now possible to keep essential services running successfully even when the grid tripped out.

ELECTRICITY IN THE COAL INDUSTRY

A paper on "The Use of Electricity in the Coal Industry" was then presented by Mr. B. L. Metcalf, who said that in 1953 1,554 million kilowatt-hours were generated within the coal-mining industry and its ancillaries, and 2,605 million kilowatt-hours were purchased from the Area Electricity Boards, making a total of 4,159 million kilowatt-hours. During the same year, the coal consumption was 9·79 million tons. Assuming 30 kilowatt-hours was consumed per ton of saleable coal, the total energy consumption would be 6,330 million kilowatt-hours for an output of 211 million tons. As the consumption was steadily increasing, 30 kilowatt-hours per ton was probably on the low side.

The Coal Board had laid down as a general policy that electricity, instead of steam or compressed air, was to be used wherever possible. They also advocated that pit-head power stations should be built to utilise the lowest grades of fuel for electricity generation. Two stations were being built under this scheme, one by the Central Electricity Authority and one by the Board. The Central Electricity Authority had come to appreciate that all the available coal must be burnt, even if the quality was very low. They had therefore undertaken to purchase all

slurry and low-grade fuel and the Coal Board had agreed to suspend the erection of pit-head power stations as long as the results were economic. The matter was of extreme importance to the Coal Board whose power, heat and light costs in 1953 amounted to £37 million, and the effect on these costs of more extensive electrification and of the disposal of low-grade fuel would be watched with interest. By complete electrification, the annual bill for electricity would be £26·375 million at 1*d.* per kilowatt-hour.

A serious handicap to more rapid electrification was the presence of over 1,000 steam winders, the conversion of which was no easy task. In addition, where there were boilers at a colliery there were usually a number of steam-driven compressors, haulages and pumps and many small generating sets using exhaust steam. Partial electrification was unsound as the total energy demand was unaltered—if the output of the colliery was the same—and yet the load factor of other suppliers of energy was less.

FUTURE ELECTRICAL DEMAND

The maximum demand was approximately equivalent to 6 MW per million tons of saleable coal so that the potential total maximum demand from all sources in 1965 would be 1,440 MW. This estimate was based on a figure of 30 kWh per ton and a load factor of 5,000 hours per annum, but the energy consumption was increasing as more machinery was introduced and 6 MW per million tons might prove to be on the low side in a few years time. In this connection the importance of reliability must be stressed. Many collieries insisted on three supplies, two from a ring main and the third from a completely separate transmission system.

The annual charges on the capital cost of electrification had to be balanced against savings in operation. An analysis of the cost of electrical equipment for a colliery producing 1½ million tons of coal per annum was about £750,000, of which £229,000 was due to distribution and £101,000 to three winders.

SOME PRIMARY CONSIDERATIONS

In using electricity underground the first consideration must be safety, and constant vigilance was needed to maintain the equipment in a reliable condition. As the shaft equipment and the roadways were made adequate to deal with larger outputs of coal there would be greater concentration of power at the coal face. Electric power was easily the most convenient medium yet operating conditions were onerous. Space was confined, ambient temperatures were usually high, the atmosphere was damp (as water sprays were used for dust suppression), heat dissipation from the electric motors was handicapped and the treatment of the machines was inevitably rough. These conditions called for the highest skill on the part of the designer to produce rugged machines suitable for the environment in which they had to work and yet easy to maintain. These points were illustrated by descriptions in the paper of modern flameproof switch and control gear, cables, flameproof and water-cooled motors, haulage equipment and lighting, communication and electronic apparatus. The author added that control circuits must be easily understood and that the basis of good maintenance began on the drawing board.

ABANDONMENT OF A DREAM

Opening the discussion on the above paper, Mr. A. R. Cooper expressed his pleasure that the author had abandoned his dream of building pithead power stations and was handing over to the Central Authority the nightmare problem of burning the semi-liquid refuse which the National Coal Board had available. He criticised the situation whereby the National Coal Board, the Gas Board and the Central Electricity Authority were all carrying out research into gas turbines. There was room for much more collaboration and interchange of information on this subject.

Mr. G. G. Pierson said it would be helpful to know how long an average colliery could manage without a supply under emergency conditions. The mining industry should consider using 11-kV instead of 6·6-kV, which was now regarded as the ceiling.

Mr. F. J. Lane pleaded for close consultation with the supply industry on the design of equipment as a great deal of trouble could arise from unsatisfactory protective arrangements.

A DIFFICULT TASK

Lord Citrine said that Mr. Metcalf had had a more difficult task in promoting the electrification of coal mining than anyone unacquainted with the industry would realise. The electrical engineer could help a great deal in what must necessarily be a slow and uphill task. He had been struck by the lack of portability of electrical and other mining apparatus. It would be a boon if the equipment could be made lighter, and he was sorry, therefore, to hear that aluminium had been banned from the coal face.

Mr. J. R. Harding commented on the fact that there was apparently only one electric pantograph locomotive installation. If the reason was lack of headroom for the trolley wires, consideration might be given to other methods of supply, such as had been developed for overhead cranes where bare wires were not permitted.

Mr. C. H. E. Ridpath asked whether the ban on aluminium extended to experiments with aluminium-cored cables.

Mr. B. L. Metcalf, in reply, said that the time for which a pit could be left without a power supply depended on pumping and ventilating conditions. The cost of using 11 kV instead of 6·6 kV underground was fantastic. Aluminium had been withdrawn from the coal face because explosions had occurred owing to its use. It was not the headroom which restricted the use of trolley locomotives, but the regulations.

THE CHEMICAL INDUSTRY

At the meeting on Thursday afternoon, June 30, a paper on "The Use of Electricity in the Chemical Industry" was presented by Mr. G. Nonhebel. Some of the distinctive features of this industry in respect of its use of electricity were the presence of processes, such as the production of calcium carbide, chlorine and caustic soda which could not otherwise be effected; the large number of continuous operations with load factors of over 80 per cent. and maximum demands exceeding 30 MW; the need to make the most effective use of the large quantities of low pressure steam required for continuous processes; and the remote control of processes carried out under sterile conditions or involving explosive or toxic hazards.

A difference between chemical and other plants was the tendency to spread them over a wide area, partly in order to avoid damage due to escapes of noxious materials or to fires and explosion, and partly to allow for the installation of additional equipment, often outside the main buildings. Consequently, the distances between plants might be great. It was therefore technically desirable, as well as economic, to distribute power at a high voltage.

CONTINUOUS OPERATION

There was a growing tendency to work continuously day and night. The electrical equipment must therefore be capable of operating for long periods without any sign of breakdown, and "planned maintenance" systems were essential. Safety obligations must also be given the utmost consideration. Whereas in other industries there were seldom changes in the electrical layout, in the chemical industry alterations and new plant were frequently required, owing to research offering new processes and products. There was an increasing tendency to dispense with housing for as much as possible of the chemical plant with the result that much electrical equipment was either entirely in the open or had only a small rain shield over it. It might also be exposed to dust and corrosive gases. Special designs involving the use of unusual materials were required to minimise breakdown arising from these conditions and many flameproof motors were employed. The design of the motors, starters and other equipment installed to meet these conditions was discussed in detail, attention being particularly called to the desirability of standardisation.

THE PLACE OF INSTRUMENTATION

Modern instrumentation, including process control, offered the possibility of increasing the operating efficiency of chemical processes; and was therefore being employed to an increasing extent. Perhaps the most important contribution of electrical instruments to process efficiency would be the use of computers for control. Progress towards this end could be accelerated by providing measuring and control equipment which was more rapid in response, more consistent in use and absolutely reliable. In general, the requirements of the chemical industry for the lighting of buildings and roads were the same as for other industries. Where the atmosphere was corrosive or explosive, however, special fittings had to be designed. These included a fluorescent lighting fitting in which all the metal parts were shrouded in polyvinyl chloride and installations into which air, nitrogen or carbon dioxide at a pressure of a few inches water gauge was pumped. Where it was necessary to work in large tanks which had held inflammable liquids, air-driven portable electric lamps, supplied from a generator with an output of 40 watts at 150 volts, were sometimes used.

BACK-PRESSURE GENERATION

As the chemical industry was a large user of low pressure steam there was a great scope for back-pressure generation. It had become the practice to instal electric drives except where the utmost reliability was required or where steam drives were preferable owing to fire risks. There was therefore likely to be a continuous increase in the ratio of electricity to process steam consumption. Although careful consideration had to be given to the balancing of the steam and electrical loads, there was no need to make a fetish of it, as steam reducing valves and connection to the public supply could deal with off-balances. The main thing was to ensure that all process-plant steam requirements were at minimum operating pressure; those plants requiring higher pressures should be supplied separately, either through reducing valves or from bled turbines.

An examination of the economics of back-pressure generation should be made when old boilers were replaced; and to encourage it a range of standard sets with outputs of from 500 to 5,000 kW and an average power factor of 0·9 should be made available. The turbines of these sets should be operated at standard inlet and back-pressures and should be connected to standard equipment for running in parallel with the grid. More research was required on the problem of increasing the ratio of electricity to low pressure process steam, and development of the most promising of the new cycles suggested should be sponsored in the form of reasonable sized commercial prototypes in sufficiently large factories to enable them to be run as continuously as possible to supply marginal quantities of power and steam. More attention to the design of less costly protective equipment for parallel running was also necessary.

STAND-BY SUPPLIES

Summarising the arguments in his paper the author said that chemical processes required more and more rigid control and hence continuing improvement in the reliability of the equipment. Some form of stand-by supply was necessary for parts of many continuously-running factories and arrangements must be made for safeguarding the supply to essential drives. Research and development were required to improve variable-speed alternating-current motors and on corrosion-resistant metals for their com-

mutators. General-purpose motors with higher power factors should be developed and motors for flameproof or dusty or highly corrosive conditions improved. Safer portable electrical equipment and cheaper protective gear were also required. Electrically-driven valve operating gear for use with automatic control systems should be redesigned; and the power factor of inductance furnaces for melting metal should be improved.

THREE TYPES OF PROBLEM

Opening the discussion on this paper, Mr. W. A. Gallon said that there were three types of problem in the chemical factory: those due to hazards where, if the engineer could not find a solution, the chemist must alter the process to make it safe; those necessary to ensure the continuity of supply, where if the normal arrangements were insufficient much could be done by providing Diesel generation or by a central power station supplying an emergency network; and those relating to methods of control, where the collaboration of the chemist in stating his wants, of the electrical engineer in providing them and of the electronic engineer would eventually lead to satisfactory solutions.

Major H. E. Knight pointed out that while the engineer had gone to great trouble in standardising motors and control gear, the user could give still more help in this direction. The beneficial effects of research and good design were often nullified by bad maintenance. For portable tools he recommended a 110-volt system with the centre point earthed giving a maximum of 55 volts to earth.

Mr. G. M. H. Houston thought that motor control gear was likely to become more complex. In the United States there were machines with 250 motors so that reliability was inconsistent with simplicity. Reliability should not be sacrificed to ease of maintenance.

Dr. S. Whitehead, referring to flameproofness and intrinsic safety, pointed out that development had now caught up with research. New problems, had, however, arisen including a widespread prevalence of difficult gases, higher powers, larger equipment and internal arcing. Present designs might have an unnecessarily high factor of safety for uses for which they had not originally been contemplated. The attempts to avoid costly designs by preventing explosions from spreading, or by rendering the electric discharges innocuous, were interesting. The most economical solutions seemed to lie in the latter direction, particularly for electronic and other controls and accessory gear. Improvements in separation should be possible by studying sealing and the design of gaskets. The technical co-operation of the user industries was most encouraging.

The President drew attention to the fact that during the last five years the consumption of electricity in the industry had increased by 65 per cent., and he saw no reason why this should not continue. It was difficult to determine where the sphere of the chemical engineer ended and that of the electrical engineer began. The greater co-operation between them the better.

The author, in reply, said that if a standard article was available many users would accept it, but if not they tended to insist on getting their exact requirements. He did not regard it as sufficient to bring in portable equipment for inspection only once a week.

ELECTRICITY IN CATERING

Dealing with "The Use of Electricity in the Catering Industry" Mr. F. A. Rogers at the same meeting stressed the importance of this vast trade to the electrical industry, especially as it was doubtful if more than 2½ per cent. of the equipment in use in this country was heated in that way. Most of it was installed in factory canteens, schools and the smaller establishments. The industrial catering load usually fitted in well with the factory demand without increasing the maximum demand so that all the electricity consumed was at the low unit rate.

The paper therefore aimed at encouraging everyone concerned in the electrical industry to take a more lively interest in this field. It also referred to the various classes of catering establishments and their load characteristics as well as to the running, maintenance and depreciation costs of electrically-heated equipment, compared with that operated by other forms of fuel. More attractive and simplified tariffs were urged as an inducement to install modern electrical equipment and the hope was expressed that means would be found for trained personnel of the Area Boards to provide advice and service.

In the course of the discussion on this paper, Mr. J. Gogan said that one difficulty in securing a large share of the catering load was tariff complication. In the south of Scotland they had therefore introduced a flat rate tariff, which also encouraged off-peak loads.

Mr. C. W. S. Williams was of opinion that the electrical industry was losing great opportunities in the catering field where there was a good potential off-peak load. The first essential was a simple tariff.

Miss M. V. Griffith said that the proper exploitation of the heat pump would result in mutual co-operation between the heating and cooling loads in the catering industry.

Mr. W. Gilchrist regarded it as important to ensure that all new commercial buildings were completely electric. The first thing to sell was heating, because that would bring water-heating and cooling with it. There was also a vast field in ventilation in which we were very backward.

ANNUAL DINNER

The annual dinner was held in the Corn Exchange on Thursday evening, June 30, the President being in the chair.

The toast of "The Electrical Industry" was proposed by the Minister of Fuel and Power (the Rt. Hon. Geoffrey Lloyd, M.P.), who said that it was one of the most dynamic and successful in the world. Its very success, however, raised the problem of how to secure the fuel for the tremendous increase in plant which would be necessary to meet the needs of industry. For the remainder of the century coal must be the basic fuel, but it would be necessary to supplement it with oil and atomic energy. The Government was determined that in one way or another during the next five years the industry had all the fuel it needed.

The President, in reply, said that the goal of doubling our standard of living during the next 25 years could only be reached if the electrical industry could supply the power that was required. He therefore appealed for co-operation in removing certain prejudices and obstacles. In the first place, the industry should continue to be left out of party politics. Secondly, the community should rid itself of generalisations, half truths and labels. For example, the public often spoke of the necessity of producing only in the largest units and of the need for decentralisation. Each case must, however, be decided on its merits. Monopolies—that popular playground of self-appointed guardians of the public—were another example. The criterion of service was whether or not in the end, overall and not in detail, an organisation rendered good service to the country.

Further, industry suffered from the suggestion of conflict in the terms "capital and labour," "employers and workers," a disability which implied that there was a diversity of purpose and aims. Nothing could be further from the truth. The small differences which always existed in any community must not be exaggerated and those who had contributed to progress must be allowed to participate in the success achieved.

The toast of "The Guests" was proposed by Mr. J. R. Beard. Alderman Eric Simms replied in the absence of the Mayor.

AN ELECTRICAL FORUM

On Friday morning an "Electrical Forum" was held in the Dome, the panel consisting of Sir Claude Gibb, Colonel B. H. Leeson and Messrs. J. Eccles, C. R. King and A. M. F. Palmer, M.P., the President being in the chair. The panel generally agreed that Area Boards should take "common business risks" and encourage off-peak development, although Mr. Eccles pointed out that the margin between day and night costs was only 0·06*d*. Sir Claude Gibb emphasised the importance of building load factor by night loads, especially those of the thermal storage type. Mr. King thought that Area Boards should take the risk of lowering unit charges for off-peak loads to attract business.

As regards the limit of size of generating unit for two-shift operation during the next ten years, Sir Claude Gibb saw no difficulty in going up to 350 MW with cross-compound machines, although with in-line machines 250 MW was probably the present limit. Asked whether Boards and Divisions should not use larger numbers of electric vehicles, Mr. King said they were not really competitive with petrol vehicles and were not suitable for meter readers. Colonel Leeson called attention to the fact that fundamental research was being conducted into better ways of storing electricity, and Mr. Palmer agreed that if one could be found it would revolutionise the position. Mr. Eccles thought Boards might use the electric vehicle more in urban areas.

In answering a question whether consultative Councils were of real value to the consumers and whether they should be given executive authority or abolished, Mr. King said they were now working satisfactorily, but he objected, as did Sir Claude Gibb, Mr. Palmer and Mr. Eccles, to their being given executive functions. Colonel Leeson favoured their abolition. The need for more socket outlets in houses was stressed by all the members.

POWER STATION CONSTRUCTION

The final question dealt with the most probable bottlenecks in power station construction during the next decade. Mr. Eccles thought shortage of labour in structural engineering might be the answer. Sir Claude Gibb agreed that manpower shortage would be the main difficulty, while Mr. King and Mr. Beard called attention to the delays in obtaining consents and dealing with objection. Colonel Leeson pointed out that as generating sets increased in size, transport became more difficult, an obstacle which would remain until our roads were improved.

The Convention closed with the annual general meeting at which Sir John Dalton and Mr. J. Eccles were elected president and vice-president, respectively, for the ensuing year. It was announced that the 1956 Convention would be held at Torquay from Thursday, May 24, to Tuesday, May 29.

★ ★ ★

100-WATT VIBRATOR

For the inversion of a direct-current supply to alternating current the Plessey Company, Limited, Ilford, Essex, have produced a 100-watt heavy-duty vibrator which was originally designed for use in the Services. Input is 8 amperes at 24 volts direct current, and output can be at 350 or 175 volts direct current or 12 or 6·3 volts alternating current. The overall efficiency is about 60 per cent. The vibrator is hermetically sealed in a robust aluminium case of such wall thickness that mechanical noise is kept to a low level; size of the unit is 4¼ in. high by 2¾ in. diameter.

The vibrator is of the synchronous type, working at a frequency of 110 c/s nominal, having a split reed and a separate drive, and taking a maximum of 5 watts driving power. The platinum-iridium tipped drive contact screw connects to a platinum-iridium contact spun on to the drive contact spring, made from high-quality spring steel. The power contacts are made from close-grain swaged tungsten. The vibrator has twin reeds, and to ensure uniformity of material the reeds are made in one piece connected together by a small web which is removed after the vibratory system is assembled.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Electronic Concentration of Low Grade Ores with the Lapointe Picker. By A. H. BETTENS and C. M. LAPOINTE. Technical Paper No. 10. *Department of Mines and Technical Surveys, Mines Branch, Radioactivity Division, Ottawa, Canada.* (25 cents.)

Constructional details are given of a new electronic picker unit for the concentration of coarse, low-grade, uranium ore using a scintillation detector. Typical results obtained with low-grade ore from two mines in the Beaverlodge area are presented as examples of the concentration achieved with the higher sensitivity of such a detector. Comparative tests with a Geiger detector are also reported.

Scientific and Technological Problems Involved in Using Ionizing Radiations for the Preservation of Food. By R. S. HANNAN. Food Investigation Special Report No. 61. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.2.* (7*s.* 6*d.*)

Certain types of radiation have the ability to kill micro-organisms subjected to them, and a great deal of work has been done on possible ways of making use of this property. The possible use of suitable forms of ionising radiations in the preservation of foods has for five years been the subject of research by the Food Investigation Organisation of the D.S.I.R. It has been established that, although the cost of equipment is high, sterilisation by bombardment with electrons or X-rays could possibly be carried out on a commercial scale at a comparatively low cost. Difficulty has been experienced, however, in assessing the effect on foodstuffs of such bombardment and some of the many adverse changes which can result are not yet fully under control. The report discusses fully the various types of radiations, their properties and their effects on animal products, fruit and vegetables, miscellaneous products and packaging materials.

Food Investigation, 1954. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.2.* (3*s.*)

In this report of the Food Investigation Board the progress of research is related to changing conditions in the industries involved. The work described includes experiments on the freezing of beef carcases; sterilisation of foods by irradiation; the use of micro-the organisms as a source of food; investigation on strength of egg shells; a quick test for the freshness of fish; the use of aureomycin for the preservation of fish; the electrostatic smoking of fish; and experiments on the storage of home-grown fruit.

Leather Research and Technology at the National Bureau of Standards: A Review and Bibliography. By EVERETT L. WALLACE. National Bureau of Standards Circular 560. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (15 cents.)

This review gives a summary of the Leather Section Organic and Fibrous Materials Division of the National Bureau of Standards. Some of the more important work described includes the establishment of the optimum pH of 3·0, below which leather is not stable during storage; a method for the quantitative determination of amino acids in collagen; the measurement of the size and distribution of pores in leather; methods of impregnating leather with polymers; measurement of the physical constants of leather and other polymers; investigation of the tanning properties of synthetic organic compounds; and the construction and design of special equipment for laboratory evaluation of performance.

Sonics: Techniques for the Use of Sound and Ultrasound in Engineering and Science. By THEODOR F. HUETER and RICHARD H. BOLT. *John Wiley and Sons, Incorporated,* 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (10 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.2.* (80*s.*) (Reviewed on page 753 in the issue of June 17.)

The Bomb, Survival and You: Protection for People, Buildings, Equipment. By FRED N. SEVERUD and ANTHONY F. MERRILL. *Reinhold Publishing Corporation,* 430 *Park-avenue, New York* 22, *N.Y., U.S.A.* (6 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.2.* (48*s.*) (Reviewed on page 781 in the issue of June 24.)

Liberal Education in a Technical Age. *Max Parrish and Company, Limited,* 55 *Queen Anne-street, London, W.1.* (6*s.*) (Reviewed on page 753 in the issue of June 17.)

ALUMINIUM-ALLOY CONCAVE-POINTED RIVETS

SMALL LOADS SUFFICE FOR CLOSING

By J. D. Haddon, M.B.E., B.SC., F.R.AE.S.*

It is well known that the cold driving of aluminium-alloy rivets requires greatest forces than are necessary if large diameter rivets of conventional design are used. Much thought has been devoted recently to finding an efficient point shape that may be driven without excessive force. Investigations of the behaviour of rivets have ranged from those with the conventional points used for hot-driven steel rivets, through pan and recessed points, to headless and pointless rivets.

The cold driving of rivets brings into prominence the distribution of load between rivets in an axially-loaded joint. Instead of the thermal contraction of the rivet holding the plates together, the cold alloy rivets elongate elastically on the removal of the squeeze load. This was illustrated clearly by Whitman[1] who showed a gap of approximately 0·007 in. between the plate and a conical point of a ½-in. diameter AW13 rivet after the squeeze stress of 110 tons per square inch of shank had been removed. Further investigation has shown that this gap is not apparent with a squeeze stress of 30 tons per square inch of shank. This reduction of gap with driving force may be noticed in an illustration published by Bailey and Brace.[2] However, a reduction in the gap does not imply a pressure between plates. Friction between the plates, which is largely responsible for transferring the design loads of steel joints, is virtually absent. It follows, as shown by Francis,[3] that during elastic strain the load distribution along a row of rivets in the line of load will be approximately hyperbolic, the end rivets taking by far the greatest load. Although this load will be evened out by yielding before static failure, the large stress concentrations at the end rivet may seriously affect the fatigue strength of the joint.

It was shown by Whitman from tensile tests on conical pointed rivets that the clearance between the plate is not taken up until about 40 per cent. of the failing strength is reached, and that this corresponded nearly to the strength with the head and point removed. Barlow[4] also tested headless rivets and found that a rivet with a pointless end when squeezed with a flat set flush with the plates had no appreciable tensile strength.

Whitman attributed the tensile strength of the pointless rivet to the frictional grip of the rivet in the hole. There appeared little justification for this assumption and on examination it was found that the rivet and the hole were distinctly tapered inwards. In the case of a ½-in. diameter rivet, with a reduced pan point, the diameter had tapered by 0·014 in. from the surface to the inter-face of the plates. It was with the purpose of taking advantage of this taper that the investigation being reported was undertaken at the Royal Military College of Science.

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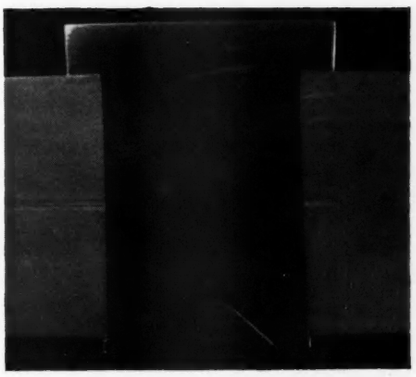


Fig. 1 Section through a light-alloy rivet with a concave point driven with a 90-deg. conical set. The rivet is tight in the hole, the plates are tight together and there is no gap under the head.

SCOPE OF INVESTIGATION

It was proposed to use conical sets to reduce the squeeze load and, at the same time, make the taper more pronounced. This led from headless and pointless rivets to those with both heads and concave points. A section of a concave HE10W rivet, riveted with a 90 deg. conical set under a squeeze load of 15 tons, is shown in Fig. 1, herewith. The point protruded $\frac{1}{16}$ in. beyond the plate before driving. It will be observed

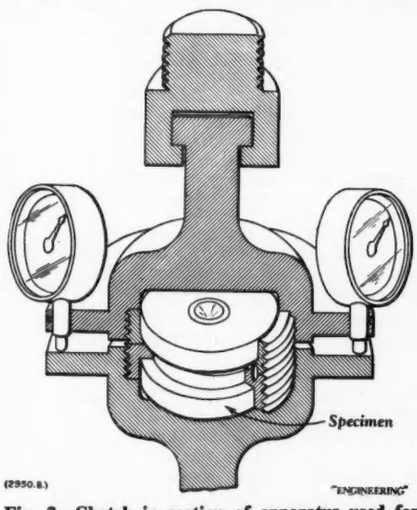


Fig. 2 Sketch in section of apparatus used for tension tests on riveted specimens. The plates of the specimens are machined to fit the grips. Extensions under load are measured directly on the gauges.

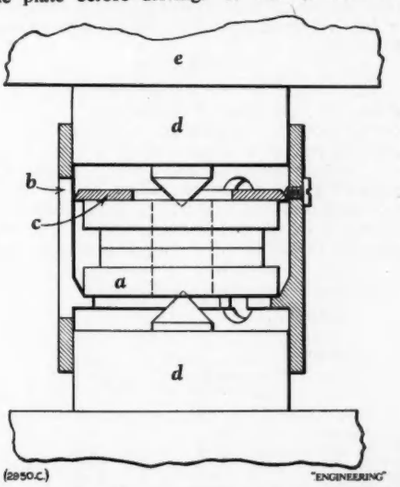


Fig. 3 Assembly jig used for riveting the specimens. Where headed rivets were used, one of the conical sets was replaced by a flat dolly.

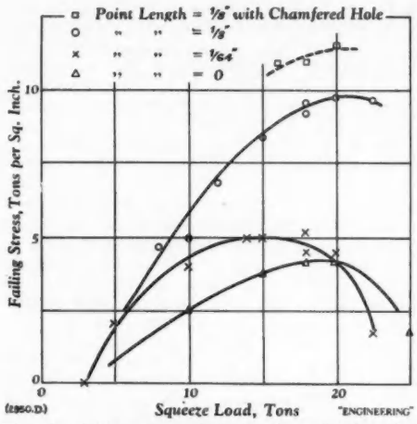


Fig. 4 Failing strength in tension of ¾-in. diameter rivets of HE10WP closed with 90-deg. conical sets by different squeeze loads.

Fig. 5 Increase in rivet-shank diameter at varying distances through the plates.

Material, HE10WP. Plates ½ in. thick. Original rivet diameter 0·747 in. Hole diameter 0·748 in. Squeeze load 14 tons. 90-deg. sets. Point length $\frac{1}{64}$ in.

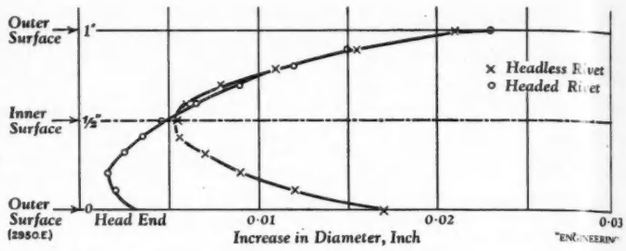


Fig. 6 Variation with squeeze load of the increase in rivet-shank diameter at varying distances through the plates.

Material, HE10WF. Plates ⅜ in. thick. Original rivet diameter 0·747 in. Hole diameter 0·748 in. 90-deg. sets. Points length $\frac{1}{32}$ in.

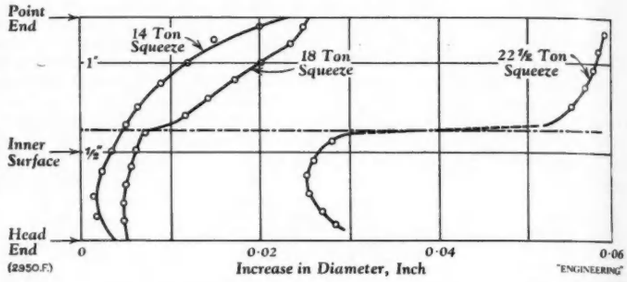
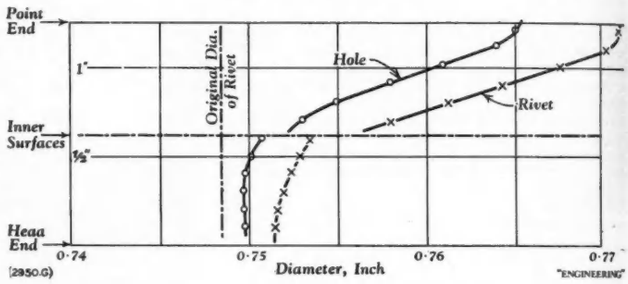


Fig. 7 Increase in rivet shank and hole diameter at various distances through the plates.

Material, HE10WP. Plates ⅜ in. thick. Rivets 0·747 in. diameter with head. Hole diameter 0·748 in. 90-deg. sets. Squeeze load 18 tons.



that the rivet is tight in the hole, and that there is little, if any, gap under the head due to elastic recovery on removal of squeeze load. It will also be noticed that the plates are hard together, though in one place there is a slight gap due to unevenness of the plate surfaces.

It was decided to reduce the number of variables by concentrating on ¾-in. diameter rivets. (Actual rivet dia.: 0·747 in.; hole dia.: 0·748 in.) HE10WP (AW10B) alloy was first used for both plates and rivets to conform to that recommended by Whitman[1], for which he used a squeeze load of 35 tons for reduced pan points and 25 tons for recessed points. An apex angle of 90 deg. was chosen for the set after a preliminary test had shown this to be about optimum for rivets of ¾-in. diameter.

Although a joint should be designed to avoid tension in the rivets, there is always a tendency for a rivet to pull out of its hole as the joint, rivet and hole distort. It was decided to consider resistance to tension as the first criterion for the efficiency of riveting. It was expected that the rivet point would have comparatively small effect upon shear strength and that the difficulty would be to obtain reasonable tensile strength.

B.S. 1974 (1953), with one exception, recommends points that develop the full tensile strength of the rivet shank. However, there appears to be little advantage, and much disadvantage, in using large or complicated points when the rivets are required to transmit the force by bearing and shear only. Apart from the greater driving force, the larger spring back is likely to lead to pockets of corrosion and possible reduction of water tightness, particularly if the rivet should barrel under excessive squeeze force.

APPARATUS

The plates for the tensile tests were ⅝-in. thick, 2½-in. overall diameter and machined to fit the grips, illustrated in Fig. 2. In this manner the rivet would be in tension when the built-up specimen was pulled between the grips of a tension-testing machine. The extension and pull-out of the rivet under load were measured by the dial gauges shown. A correction for the strain of the apparatus and plates was obtained by using a steel bolt of known load-extension in place of the rivet.

The actual properties of the material, which varies considerably for the same specification, were tested for all bars used. The results are given in Table I.

Tensile specimens were riveted while assembled in the sleeve, *b*, shown in Fig. 3. The specimen, *a*, shown with a headless rivet, was held in position by the ring, *c*. The two conical sets *d* were constrained to move vertically and centrally by their running fit in the sleeve when compressed between the platens, *e*, of a hydraulic testing machine. With headed rivets the bottom set was replaced by a flat dolly to hold the head. Joints for shear tests were held manually during the squeezing process, which was done in 100-ton hydraulic compression-testing machine.

TENSILE STRENGTH

Tests were made first on rivets which were of unmachined lengths equal to the thickness of the two plates of HE10WP extruded bar of ¾-in. diameter. These were riveted under varying squeeze loads with the 90-deg. conical sets, and then tensile tested. The maximum strength obtained was 4½ tons per square inch of shank cross-section when the squeeze load was 20 tons. It was noticed that the rivet had contracted and did not quite reach the surface of the plates, so lengths were increased to allow the ends to protrude by $\frac{1}{64}$ in. before driving. This distance will be called the "point length" in future reference. Results showed an increase of maximum strength to 5 tons per square inch, and are given in Table II and Fig. 4.

It will be noticed that there is a rapid reduction in strength above a squeeze load of about 20 tons. This was thought to be the result of the rivet barrelling under compression. When this occurred the plates were slightly lifted apart on removal of the squeeze load. For future tensile tests it was decided to use a flat-headed rivet, to control the point length more easily. The head had no discernible effect upon the tensile strength.

To investigate the effect of squeezing on the rivet diameter, both headed and headless rivets

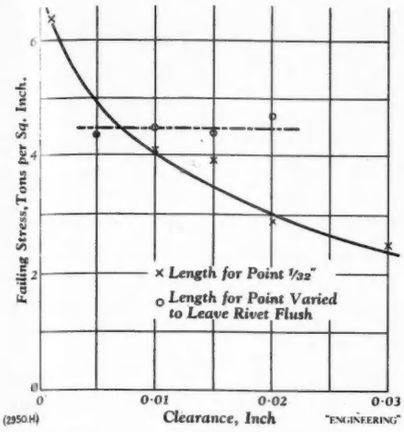
TABLE I.—PROPERTIES OF ALLOYS USED

Material	Tension		Shear		Elongation, per cent.	Brinell hardness
	0·1 per cent. proof stress, tons per sq. in.	Ultimate strength, tons per sq. in.	Ultimate strength from shear test, tons per sq. in.	Limit of proportionality from torsion test, tons per sq. in.		
Plate HE10WP ..	21·4	23·5			16	
Bar (1) do. ..	21·2	24	13		12·5	150
Bar (2) do. ..	22	24·2	16	13·2	12·5	165
Bar (3) do. ..	22	23·5	12·8	8·7	13·5	
Bar HE10W ..	10·5	16·8	11·9		34	121
Bar HE11W ..	20·6	32			16·5	169
Bar AW12A (Special) ..	13	22	17·5	7·1	23	159
Bar HE15W ..	19	33	18		15·6	205

TABLE II.—*Tensile tests on ¾-in. diameter rivets in HE10WP, with a set cone angle of 90 deg.*

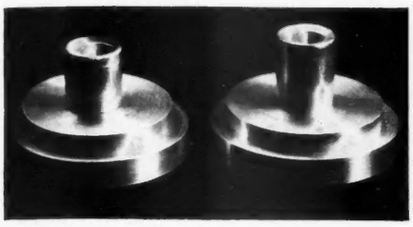
Bar No.	Squeeze load, tons	Point length, in.	Failing stress, tons per sq. in.	Remarks
3	10	0 Headless	2·52	
3	15	0 do.	3·75	
3	18	0 do.	4·2	
3	20	0 do.	4·25	
3	25	0 do.	1·75	Barrelled
3	3	$\frac{1}{64}$ do.	0	
3	5	$\frac{1}{64}$ do.	2·05	
3	10	$\frac{1}{64}$ do.	4·02	
3	14	$\frac{1}{64}$ do.	5·05	
3	15	$\frac{1}{64}$ do.	5·05	
3	18	$\frac{1}{64}$ do.	4·6	
3	20	$\frac{1}{64}$ do.	4·5	Barrelled
3	22·5	$\frac{1}{64}$ do.	1·7	do.
2	18	$\frac{1}{64}$ Headed	5·2	
1	8	$\frac{1}{8}$ do.	4·7	
1	10	$\frac{1}{8}$ do.	5·0	
1	12	$\frac{1}{8}$ do.	6·8	
1	15	$\frac{1}{8}$ do.	8·35	
1	18	$\frac{1}{8}$ do.	9·5	
1	18	$\frac{1}{8}$ do.	9·2	
1	20	$\frac{1}{8}$ do.	9·8	
1	22·5	$\frac{1}{8}$ do.	9·7	
2	16	$\frac{1}{8}$ do.	10·9	Hole chamfered $\frac{1}{64}$ in. at 45 deg.
2	18	$\frac{1}{8}$ do.	11·0	
2	20	$\frac{1}{8}$ do.	11·6	

Note.—Bar 2 is stronger than bars 1 and 3.



Material HE10WP. Rivets 0·747 in. diameter. Squeeze load, 18 tons. 90-deg. sets.

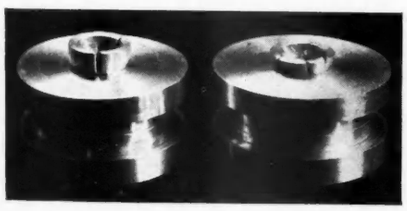
Fig. 8 Effect of increased clearance on tensile strength of riveted joint.



(*a*) (*b*)

(*a*) HE10WP; $\frac{1}{8}$-in. point; 18-ton squeeze load; tensile strength, 9·5 tons per square inch.
(*b*) HE15W; $\frac{1}{4}$-in. point; 18-ton squeeze load; tensile strength, 10·6 tons per square inch.

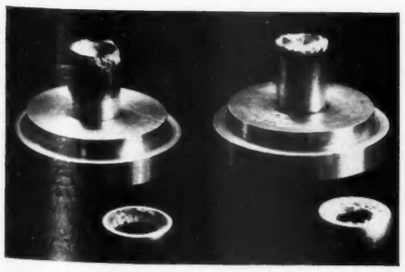
Fig. 9 Over-formed and under-formed points.



(*a*) (*b*)

(*a*) $\frac{1}{8}$-in. point; 18-ton squeeze load; tensile strength, 14·5 tons per square inch.
(*b*) $\frac{1}{4}$-in. point; 20-ton squeeze load; tensile strength, 12·1 tons per square inch.

Fig. 10 HE15W rivets with points cracked on squeezing.



(*a*) (*b*)

(*a*) Ring shear; $\frac{5}{16}$-in. point, 18-ton squeeze load; tensile strength, 13·6 tons per square inch.
(*b*) Annular tension; $\frac{7}{16}$-in. point; 18-ton squeeze load; tensile strength, 17·0 tons per square inch.

Fig. 11 Tensile failure of HE10W rivets.

Figs. 9 to 11 Specimens of "long" pointed rivets and associated forms of failure in tension.

were cut out of the plates and their diameters measured at a series of points along their lengths. The graphs of the results, shown in Fig. 5 for a 14-ton squeeze load, show clearly the taper which has been formed. Furthermore, such tests using increased squeeze loads showed that barrelling of the rivet does in fact take place, so destroying the taper and leaving little but friction to grip the rivet in the hole. The results are shown in Fig. 6. It will be noticed that the loss of taper at the driven end has begun at a squeeze of 18 tons. Although $\frac{5}{16}$-in. deep flat heads were used, considerable spread has taken place at the headed end. An increase in the outside diameter of the plates was observed, particularly with the higher loads.

It was noticed when cutting out the rivets that considerable hoop tension existed in the plates, especially after the 18-ton squeeze. In this latter case the plates burst open when there was still about $\frac{1}{16}$ in. of material to cut away. It would thus appear that there must be a small force, resulting from the pressure acting upon the tapered sides, holding the plates together.

In order to determine the cause of this pressure, four pairs of plates were riveted together under as nearly identical circumstances as possible using an 18-ton squeeze load. In two cases the rivet was carefully removed and the hole measured. In the other two cases the rivet was cut out undamaged and its diameter measured. The graphs, Fig. 7, show the average results. On the point side of the joint the rivet diameter is about 0·006 in. larger than the hole, implying a considerable amount of radial stress.

As tests are normally to be made on rivets having a clearance of 0·001 in. before riveting, the next step was to examine the effect of increased clearance using a point length of $\frac{1}{32}$ in. As was to be expected, the extra material required to fill the hole resulted in a reduced point and with the larger clearances the top of the rivet was below the level of the plate. Hence the reduction of tensile strength shown in Fig. 8. When, however, the rivet length was increased in order to keep the rivet flush after riveting, a reasonable clearance had no noticeable effect.

Within the limit imposed by cracking there is no reason why point lengths should not be increased to provide a definite point. On squeezing, the length of rivet beyond the plate will spread to form a point, rather similar to the recessed point, which will fail by annular tension, ring shear or, if the squeeze load is insufficient to provide a good point, by drawing through the hole. The material beyond the hole should transfer some of the squeeze load, which is all resisted by the shank of pointless rivets, to the plate and so reduce the tendency to barrel.

Tests made with $\frac{1}{8}$-in. point lengths indicated a maximum tensile strength of nearly 10 tons per square inch with a 20-ton squeeze and no appreciable reduction of strength at a 22½-ton squeeze. The results are given in Table II and graphically in Fig. 4. A chamfer on the hole of $\frac{5}{32}$ in. at 45 deg. increased the strength to 11½ tons per square inch, but the point tended to crack on riveting with bar No. 2 of HE10WP material. This was not pursued further as it will be seen that a slightly larger point will give a greater strength without cracking.

Figs. 9 to 11 show different tensile specimens of "long" pointed rivets. Fig 9(*a*) shows a ring shear failure of an HE10WP rivet which had an $\frac{1}{8}$-in. point length and Fig. 9(*b*) an HE15W rivet which failed by drawing through the hole due to the harder material resisting penetration of the set so that the point had not sufficiently spread.

The effect of excessive squeeze load and/or point length is shown in Fig. 10: (*a*) had a $\frac{3}{8}$-in. point and an 18-ton squeeze, while (*b*) had a $\frac{1}{4}$-in. point and a 20-ton squeeze load. As may be expected, these cracks cause a reduction in strength.

Fig. 11(*a*) shows an example of ring shear failure and Fig. 11(*b*) annular tensile failure. In the latter case it will be noticed that there is considerable necking of the shank showing that the ultimate tensile strength has been reached there where the rivet retains its ductility, at the same time as brittle tensile failure has taken place at the smaller point cross-section where the material strength has been increased by cold work.

A number of tensile tests were carried out using HE10WP alloy rivets with various point lengths; the results are given in Table III and in graphical form in Figs. 12 and 13. The following points emerge.

The $\frac{3}{4}$-in. diameter rivet squeezed under 18 tons is the most efficient of those tested. It gave a maximum strength of 14½ tons per square inch with a point length of $\frac{1}{16}$ in.

Unfortunately, only a limited number of rivets could be made from any one bar, and there was found to be considerable variation of properties from bar to bar. Bar 2 was harder than bar 1, with the result that a $\frac{1}{4}$-in. pointed rivet of it cracked under a squeeze of 18 tons, so reducing its strength, whereas bar 1 rivets did not crack under this load until the point length was $\frac{3}{8}$ in. The maximum safe point length in this material for $\frac{3}{4}$-in. diameter rivets with a 90-deg. conical set would thus appear to be $\frac{3}{16}$ in. if cracks are to be avoided.

A squeeze load of 18 tons for $\frac{5}{8}$-in. diameter rivets caused cracking with $\frac{1}{4}$-in. points, but a better strength was obtained with a 12-ton squeeze.

Allowing for the difference in bar properties, it would appear that, with increased diameter, this type of rivet becomes less efficient in terms of tensile strength.

It will be noticed that for the 18-ton squeeze-loaded rivets the graphs show a greater slope at very small point lengths. This is the result of a reduction in tensile strength caused by slight barrelling, which will not occur with larger points or smaller squeeze loads.

Readings of extension were taken for some tests. The load-extension graphs, corrected for strain in the apparatus, are given in Figs. 14 and 15. In both cases of $\frac{1}{16}$-in. points, the headless rivet appears weaker. This is thought to be due to the difficulties of ensuring equal point lengths at each end with the headless rivets. The 12-ton squeezed rivets show no yield below a 1½-ton load and, in the case of the headed rivet, a very small yield at about 1¾ tons tension. The headless rivet is definitely pulling out before this load. With the 18-ton squeezed rivet there is a large yield at

TABLE III.—*Tensile Tests on HE10WP Rivets.*

All rivets with head and set angle of 90 deg. unless otherwise stated.

Bar	Rivet diameter, in.	Squeeze load, tons	Point length, in.	Failing stress, tons per sq. in.	Remarks
3	$\frac{3}{4}$	18	0	4·2	Headless
3	$\frac{3}{4}$	18	$\frac{1}{64}$	4·6	Headless
1	$\frac{3}{4}$	18	$\frac{1}{32}$	6·4	
1	$\frac{3}{4}$	18	$\frac{1}{16}$	6·35	
1	$\frac{3}{4}$	18	$\frac{1}{8}$	7·47	
1	$\frac{3}{4}$	18	$\frac{3}{16}$	9·3	
1	$\frac{3}{4}$	18	$\frac{1}{4}$	5·4	Point removed to plate surface
1	$\frac{3}{4}$	18	$\frac{1}{8}$	9·5	
1	$\frac{3}{4}$	18	$\frac{3}{16}$	11·5	
1	$\frac{3}{4}$	18	$\frac{1}{4}$	13·4	
1	$\frac{3}{4}$	18	$\frac{1}{4}$	4·7	Point removed to plate surface
2	$\frac{3}{4}$	18	$\frac{1}{4}$	10·9	Cracked
2	$\frac{3}{4}$	18	$\frac{1}{4}$	11·0	Cracked
1	$\frac{3}{4}$	18	$\frac{5}{16}$	14·4	
1	$\frac{3}{4}$	18	$\frac{3}{8}$	13·0	Cracked
2	$\frac{7}{8}$	18	$\frac{1}{16}$	4·25	
2	$\frac{7}{8}$	18	$\frac{1}{8}$	7·05	
2	$\frac{7}{8}$	18	$\frac{3}{16}$	8·62	
2	$\frac{7}{8}$	18	$\frac{1}{4}$	9·85	Cracked
2	$\frac{7}{8}$	18	$\frac{1}{4}$	9·35	Cracked
2	$\frac{7}{8}$	18	$\frac{5}{16}$	8·86	
2	$\frac{7}{8}$	18	$\frac{1}{4}$	9·2	Cracked
2	$\frac{7}{8}$	12	$\frac{1}{4}$	11·5	
2	$\frac{7}{8}$	12	$\frac{1}{16}$	12·5	
2	$\frac{7}{8}$	12	$\frac{1}{32}$	12·5	
2	$\frac{7}{8}$	12	$\frac{1}{4}$	12·7	Cracked
1	$\frac{7}{8}$	12	$\frac{1}{16}$	4·8	
1	$\frac{7}{8}$	12	$\frac{1}{16}$	5·4	
1	$\frac{7}{8}$	12	$\frac{1}{8}$	6·8	
1	$\frac{7}{8}$	12	$\frac{1}{16}$	8·7	
1	$\frac{7}{8}$	12	$\frac{1}{4}$	10·0	
1	$\frac{7}{8}$	18	$\frac{1}{16}$	4·25	
1	$\frac{7}{8}$	18	$\frac{1}{8}$	5·8	
1	$\frac{7}{8}$	18	$\frac{1}{16}$	7·9	
1	$\frac{7}{8}$	18	$\frac{1}{8}$	8·65	
1	$\frac{7}{8}$	18	$\frac{1}{16}$	10·3	Cracked

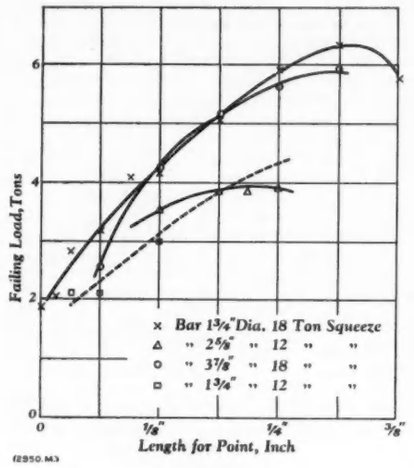


Fig. 12

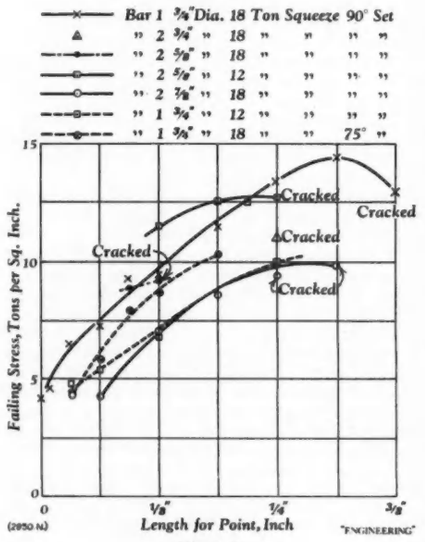

Bar 1 3/8" Dia. 18 Ton Squeeze 90° Set
" 2 3/4" " 18 " " " "
" 2 5/8" " 18 " " " "
" 2 5/8" " 12 " " " "
" 2 7/8" " 18 " " " "
" 1 3/4" " 12 " " " "
" 1 3/8" " 18 " " 75° "
Cracked
Failing Stress, Tons per Sq. Inch.
Length for Point, Inch
(2950.N.)
"ENGINEERING"

Fig. 13

Figs. 12 and 13 Tensile tests on HE10WP rivets using different sets and squeeze loads, showing that there is an optimum condition to be selected.

about 1 ton with the headed rivets, which appears to be the result of the rivet slipping in the hole on the headed side until the " Whitman gap " is closed. The second yield at about 1½ tons tension would be due to a similar gap under the point. The headless rivet having a point gap at both ends shows a bigger yield at this load, but no yield at about 1 ton. Confirmation was obtained by removing the point of one rivet, which then had a maximum strength equal to the load at which the second yield normally occurred.

Where tensile strength is more important than shear strength, it might be advantageous to use a softer and more ductile material because of the better concave point that may be formed without cracking. On the other hand, a greater tensile strength may be obtained by using stronger material, though its hardness may prevent the formation of as good a point under an equal squeeze load. Tests were made on HE10W, HE11W, AW12A and HE15W alloy rivets in HE10WP plate. The results are given in Table IV and graphically in Fig. 16.

It will be seen that the soft and ductile HE10W rivet develops the full tensile strength of the shank before failure with a $\frac{1}{16}$-in. point length. Fig. 11(*b*) shows this rivet after failure. The point, which has suffered a brittle tensile fracture, shows no sign of cracking. The shank, having also reached its ultimate strength, is necking.

The HE15W rivets were weaker in tension than corresponding HE10WP rivets because the harder material reduced the spread of the point, with the result that the point was drawn through the hole, as shown in Fig. 9(*b*). With the squeeze load increased to 20 tons, cracking occurred with ½-in. points, though with increased strength. With the 18-ton squeeze load, cracking occurred with $\frac{3}{8}$-in. point lengths. These cracked rivets are shown in Fig. 10.

The HE11W alloy, which has a similar tensile strength to HE15W, is a softer material and so makes a better headed and stronger rivet, until cracking occurs. The AW12A rivets cracked under the same conditions as the HE10WP rivets. The alloys have a similar resistance to penetration, but AW12A, though having a larger percentage elongation, fails as a brittle material, while HE10WP acts as a ductile material under compression. There appears to be no single property which gives a measure of the tendency of these rivets to crack.

SHEAR TESTS

Tests were made of typical examples of concave pointed rivets when subjected to shear, chiefly in single-riveted lap joints. In every case the plates were ½ in. thick, 3 in. wide and of HE10WP alloy. The results are given in Table V. As bar strengths vary with material of the same specification, it became necessary to add column 7: the ratio of the failing strength of the joint to the shear strength of the rivet as found from a simple shear test. This will be referred to as the shear-strength ratio. With HE10WP rivets the following points emerged.

The size of the points and the squeeze loads had little effect, except when large squeeze loads caused barrelling with small points and the rivets pulled out before shearing. With $\frac{1}{32}$-in. points, the strength increased slightly with the squeeze load, again until the rivet barrelled.

Headless rivets appeared to be slightly stronger, but not enough tests were made to be conclusive. It is, however, reasonable to expect this result.

In double shear the shear-strength ratios were practically the same as for single shear. This was especially significant in the case of $\frac{1}{32}$-in. points where the bending effect on a lap joint in single shear would be expected to be most marked.

With a row of three rivets there was a greater tendency for the end rivets to be pulled out. This was to be expected as these rivets were taking more than their share of the load before yielding and enlargement of the hole allowed the joint load to be transferred more evenly.

The HE10W rivet with the $\frac{3}{16}$-in. point had a significantly higher shear-strength ratio.

TABLE IV.—*Tensile Tests on rivets of ¾ in. diameter with head and set cone angle of 90 deg.*

Material	Squeeze load, tons	Length for point, in.	Failing stress, tons per sq. in.	Remarks
HE10W	10	$\frac{1}{32}$	3·3	
do.	15	$\frac{1}{32}$	4·3	
do.	18	$\frac{1}{32}$	4·5	
do.	20	$\frac{1}{32}$	2·3	Barrel
do.	18	$\frac{1}{8}$	8·5	
do.	18	$\frac{1}{4}$	12·2	
do.	18	$\frac{3}{32}$	13·6	
do.	18	$\frac{3}{8}$	15·5	
do.	18	$\frac{7}{16}$	17·0	Pronounced necking of rivet
HE11W	18	$\frac{1}{32}$	4·75	
do.	18	$\frac{1}{32}$	5·75	
do.	18	$\frac{1}{8}$	7·4	
do.	18	$\frac{3}{32}$	10·2	
do.	18	$\frac{1}{4}$	12·9	Slight crack
do.	18	$\frac{3}{32}$	12·5	Cracked
AW12A	18	$\frac{1}{32}$	4·73	
do.	18	$\frac{1}{32}$	6·06	
do.	18	$\frac{1}{8}$	8·35	
do.	18	$\frac{3}{32}$	8·96	
do.	18	$\frac{1}{4}$	10·6	
do.	18	$\frac{3}{32}$	12·8	
do.	18	$\frac{3}{8}$	9·9	Cracked
HE15W	18	$\frac{1}{32}$	5·46	
do.	18	$\frac{1}{32}$	6·3	
do.	18	$\frac{1}{8}$	7·5	
do.	18	$\frac{1}{4}$	10·5	
do.	18	$\frac{3}{32}$	11·9	
do.	18	$\frac{3}{8}$	14·5	Cracked
do.	18	$\frac{1}{16}$	11·1	Cracked
do.	20	$\frac{1}{4}$	12·1	Cracked
do.	22·5	$\frac{1}{32}$	2·5	Barrel

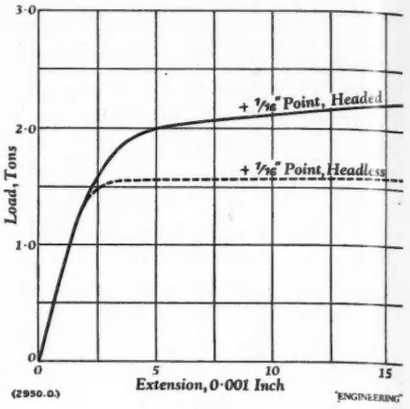


Fig. 14

¾-in. diameter rivets; squeeze load, 12 tons.

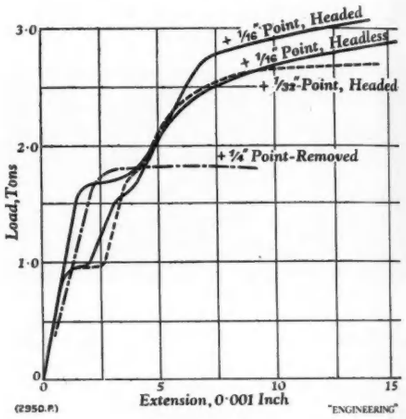


Fig. 15

¾-in. diameter rivets; squeeze load, 18 tons.

Figs. 14 and 15 Extensions of the rivet shanks as determined in the tensile tests on HE10WP rivets.

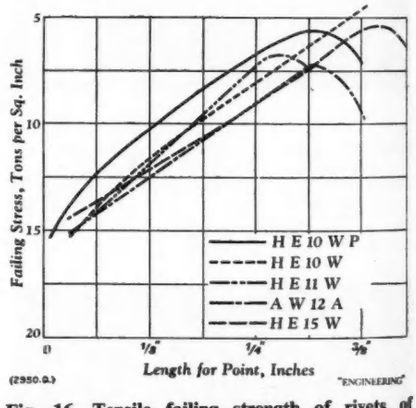


Fig. 16 Tensile failing strength of rivets of different alloys. The plates were all of the alloy HE10WP, the rivets ¾ in. in diameter, made with 90-deg. sets and a squeeze load of 18 tons.

The AW12A rivets were more sensitive to both cracking and barrelling.

HE15W, being comparatively strong in shear, the rivets of this material, with small points, had a greater tendency to pull out than to shear. The shear-strength ratio was good.

Fig. 17 shows the failure of a HE10WP (bar 3) headless rivet squeezed at 7½ tons; Fig. 18 shows an HE10WP (bar 2) headed rivet that was squeezed at 18 tons, and Fig. 19 a similar rivet squeezed at 15 tons which pulled out. All the point lengths were $\frac{1}{32}$ in.

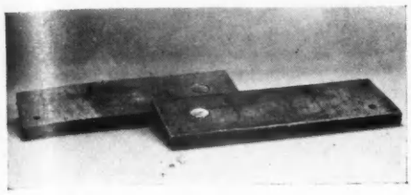


Fig. 17

Squeeze load, 7·5 tons; failed at 5·1 tons.

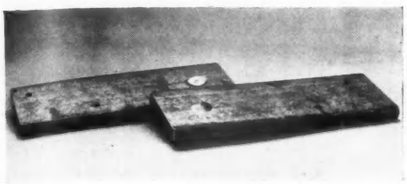


Fig. 18

Squeeze load, 18 tons; failed at 6·2 tons.

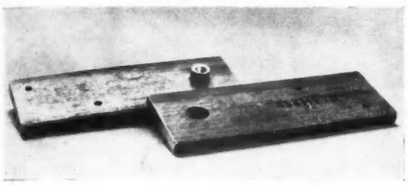


Fig. 19

Squeeze load, 15 tons; failed at 6·0 tons.

Figs. 17 to 19 Failure of single-rivet lap joints under shear loads. Point lengths and squeeze loads both helped to determine whether the rivet sheared or pulled out.

Approximate load-deflection curves were obtained for two sample single riveted lap joints by the simple process of fitting a mechanical strain gauge to read the relative movement of points on the two plates, as shown in Fig. 20, herewith. The average of two tests was taken for each case. The load-deflection graphs given in Fig. 21 show that the stiffness of the joint compares favourably with that using NR6 rivets with conventional point given by Francis.[3] The headless rivet, although of weaker material, showed less early strain because its point was larger and gripped at both ends, thus preventing early slip in the hole with resulting uneven bearing pressure. Both joints had approximately the same shear-strength ratio.

TABLE V. SHEAR TESTS

All rivets with head unless otherwise stated and of ¾-in. diameter with 90-deg. conical set.

(1) Number of rivets in line of pull	(2) Material	(3) Squeeze load, tons	(4) Excess length for point, in.	(5) Failing stress, tons per sq. in.	(6) Ultimate shear strength of material, tons per sq. in.	(7) Shear strength ratio (5)/(6)	(8) Type of failure	(9) Remarks
				Single	Shear			
1	HE10WP (Bar 3)	7·5	1/16	11·6	12·8	0·91	Shear	Headless
1	do. do.	9·5	1/16	12·0	12·8	0·94	do.	Headless
1	do. (Bar 2)	11	1/16	12·5	16	0·78	Pull out	—
1	do. do.	13	1/16	12·9	16	0·81	Shear	—
1	do. do.	15	1/16	13·6	16	0·85	Pull out	—
1	do. do.	18	1/16	14·1	16	0·88	Shear	—
1	do. (Bar 1)	20	1/16	11·8	13	0·91	do.	—
1	do. do.	22	1/16	10·1	13	0·78	Pull out	Barrell
1	do. (Bar 2)	18	1/8	14·7	16	0·92	Shear	—
1	do. do.	18	1/8	14·8	16	0·92	do.	—
1	do. (Bar 1)	18	1/8	11·4	13	0·88	do.	—
1	do. do.	10	1/8	11·4	13	0·88	do.	—
1	do. (Bar 3)	10	1/8	11·4	12·8	0·89	do.	Headless
1	do. do.	15	1/8	11·7	12·8	0·90	do.	Headless
1	do. do.	16	1/8	11·7	12·8	0·9	do.	Headless
1	do. do.	20	1/8	11·8	12·8	0·92	do.	Headless; crack under squeeze load
1	do. (Bar 1)	22	1/8	11·7	13	0·9	do.	—
3	do. (Bar 3)	18	1/16	11·2	12·8	0·88	Pull out	Headless
3	do. (Bar 2)	18	1/16	11·7	16	0·73	do.	—
3	do. do.	18	1/8	14	16	0·88	Shear	—
1	HE10W	18	1/16	9·4	11·9	0·79	Pull out	Rivet barrelled
1	do.	18	1/16	11·5	11·9	0·97	Shear	—
1	do.	18	1/8	11·6	11·9	0·98	do.	—
1	do.	18	1/16	12·1	11·9	1·12	do.	—
1	AW12A	18	1/16	12·3	17·5	0·7	Pull out	Slight barrelling
1	do.	18	1/8	15·6	17·5	0·89	Shear	—
1	do.	18	1/16	15·3	17·5	0·87	do.	Slight crack under squeeze load
1	HE15W	18	1/16	15·9	18	0·88	Pull out	—
1	do.	18	1/8	18·7	18	1·04	do.	—
1	do.	18	1/16	18·1	18	1·0	Shear	—
				Double	Shear			
1	HE10WP (Bar 2)	18	1/16	14·2	16	0·89	Shear	—
1	do. do.	18	1/16	14·6	16	0·91	do.	—
1	do. do.	18	1/8	14·6	16	0·91	do.	—

GENERAL CONCLUSIONS

Concave rivets, closed with a comparatively small squeeze load, may be successfully used in joints in which the rivet is chiefly subjected to shear, if a small point length is provided to prevent the rivet pulling-out of its hole before it fails by shear.

Small point lengths and high squeeze loads lead to barrelling of the rivet shank during squeeze, which very greatly increases the tendency to pull-out. High squeeze loads and large point lengths lead to cracking of the point, which reduces the tensile strength of the rivet.

With 18-ton squeeze load and 7/16-in. point length, the tensile strength reached for HE10W rivets was equal to the ultimate strength of the shank. With the other materials tested cracking of the point prevented high tensile strength being reached. HE10WP rivets reached a tensile strength of 14·4 tons per square inch, with a 5/16-in. point length. To avoid all chance of cracking it would be safer to use a 12-ton squeeze and 3/16-in. point lengths. This gives a tensile strength of 12½ tons per square inch with the bar tested.

Clearances up to 0·02 in. have little effect so long as the final point length is not affected.

Provided the rivet can be appoximately centralised in the hole, the headed rivet has no advantage over one with a point at both ends, formed from a length of bar.

REFERENCES

[1] Whitman, J. G. "Structural Light Alloy Riveting with the High-Tensile Alloys," *The Engineer*, vol. 192, page 228 (1951).

[2] Bailey, J. C., and Brace, A. W. *Tests in the Production and Driving of Large Aluminium Alloy Rivets*, A.D.A. Research Report No. 8. And *Strength Tests on Driven Large Diameter Aluminium Rivets*, A.D.A. Research Report No. 13.

[3] Francis, A. J. *The Behaviour of Aluminium Alloy Riveted Joints*, A.D.A. Research Report No. 15.

[4] Barlow, D. A. "Aluminium Alloy Headless Rivets," ENGINEERING, vol. 177, page 398 (1954).

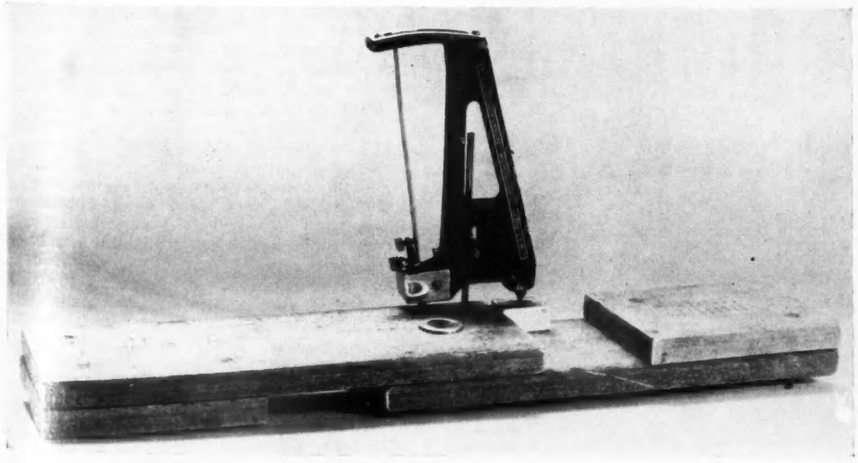


Fig. 20 Approximate deflections during shear tests were roughly measured by fitting a mechanical strain gauge on one side of the specimen.

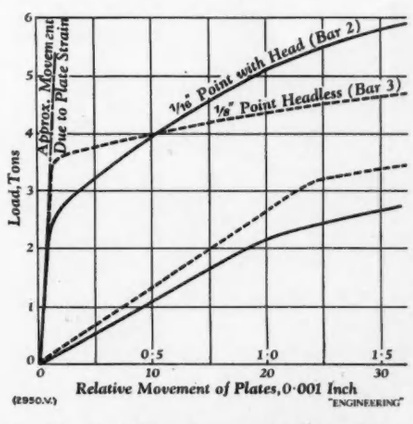


Fig. 21 Load-deflection graphs (drawn to two scales) of shear tests on single-riveted specimens. The stiffnesses of the joints compare favourably with conventional rivets.

CENTRAL ELECTRICITY RESEARCH LABORATORY

EXTENSION FOR WIDER RANGE OF INVESTIGATIONS

An extension to the research laboratory of the Central Electricity Authority at Leatherhead was opened by Lord Citrine on Tuesday, July 5. This laboratory, which was first established in 1950,* was an amalgamation of a number of smaller units which had been formed by the Central Electricity Board at Croydon, Waddon and Horsley for work on high-voltage insulators, overhead line characteristics, corrosion, transformer noise and radio and inductive interference. With the coming of nationalisation in 1948 its scope was greatly increased and the present extension is due to further investigations having become necessary into the manifold problems associated with the generation, transmission and distribution of electricity. The construction of the new wing has, in fact, led to a doubling of the accommodation available and some redistribution of the internal arrangements, which should facilitate the carrying out of a number of important researches.

SIX MAIN SECTIONS

At present the organisation is based on six subject sections under the general direction of Dr. J. S. Forrest. These sections cover transmission and distribution, electronics and instruments, generation, mechanical engineering, physics and chemistry. In addition there are photographic and general services sections, a drawing office and central workshop as well as a library, reading room and conference room. All the sections are provided with complete electricity, water, compressed air and gas services. Floor heating has been installed in the new wing thus freeing wall space and enabling advantage to be taken of an off-peak tariff. It will also enable a comparison to be made with the more usual system with which the original building is equipped.

The transmission and distribution section is naturally mainly occupied with research on the design and operation of the 132-kV and 275-kV grid transmission systems, a large proportion of the work consisting of investigations on insulators and insulating materials. The high voltage laboratory contains a 1·4 million volt generator, which is shown in Fig. 1 discharging across an insulator string, while power frequency voltages up to 250 kV root-mean-square and direct-current voltages up to 200 kV can be obtained from other equipment. Cathode-ray oscillographs are installed for recording impulse and power frequency wave forms; and power factor measurements can be made up to 250 kV root-mean-square by Schering bridges and compressed gas condensers. The apparatus, lighting and overhead runway are all controlled from a central desk, the instruments on which have been treated with fluorescent paint and illuminated with ultra-violet light so that they can be read when the laboratory is in darkness.

A high-voltage experimental transmission line is available on open ground near the laboratories. It consists of two 1,200-ft. spans of conductors which are supported from steel gantries 120 ft. wide. The phase separation and disposition of the earth wires can be varied to enable the line to be used for investigations at voltages from 250 to 500 kV between phases, and different arrangements of single and twin conductors are possible. Measurements are being made at 275 kV and 380 kV to ascertain the losses due to corona and insulator leakage. The radio-interfering field from the line is also being investigated, as is its mechanical performance.

ELECTROSTATIC PRECIPITATION

The work in the generation section is at present concentrated on electrostatic precipitation and the performance of cooling towers. For the former purpose a precipitator of the tubular type, an illustration of which is given in Fig. 2, has been erected at Leatherhead and one of the plate type at Croydon B power station. This work is already leading to a better understanding of the mechanism of electrostatic precipitation and will, it is hoped, provide more efficient and economical methods of dust collection. As is well known these precipitators extract about 98 per cent. of the grit in the flue gases and the large tonnage thus collected is being used to replace about 25 per cent. of the cement required for concrete manufacture as well as for making bricks or building blocks and as a filler for asphalt roads. In this connection it may be mentioned that to discover how far the finest fly ash will drift from a power station chimney experiments with balloons are being carried out at Little Barford, near St. Neots.

An experimental cooling tower has been erected at Croydon to enable tests to be made on various designs of packing, water distribution systems and spray eliminators. This has already led to improved methods of calculating cooling tower performance and to the development of a device for preventing the precipitation of water in the vicinity.

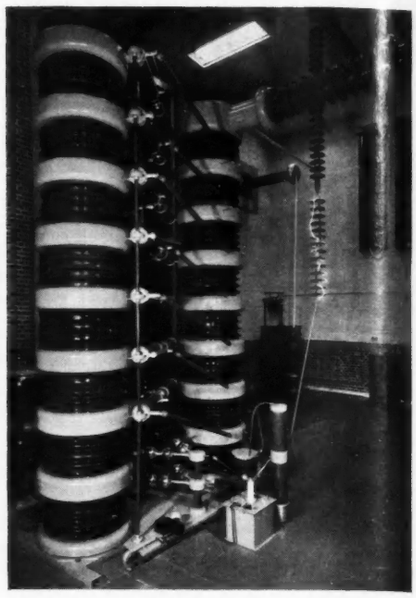


Fig. 1 The 1·4 million volt impulse generator at the Leatherhead research laboratory of the Central Electricity Authority.

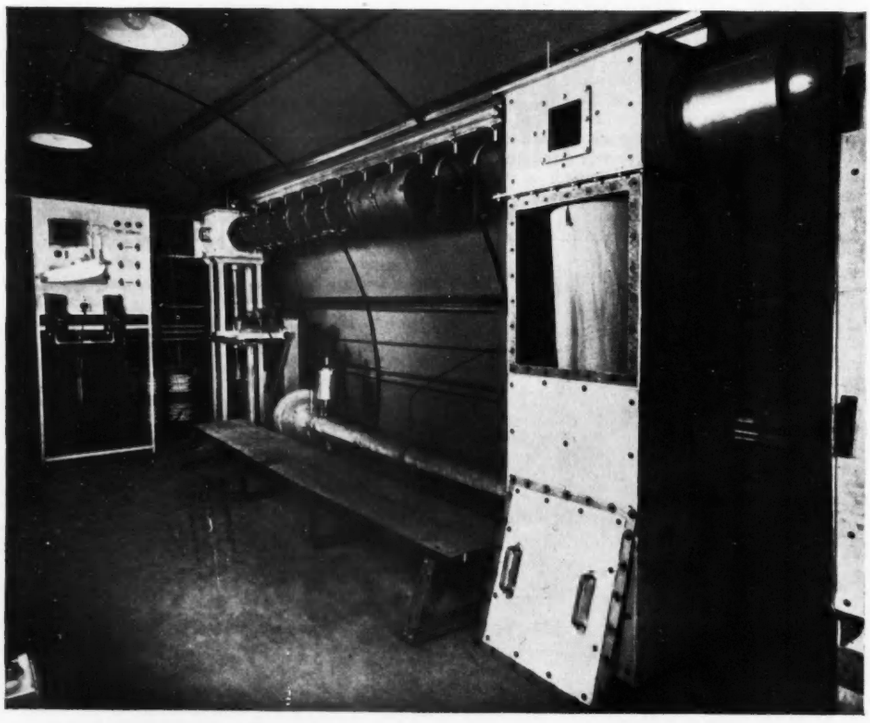


Fig. 2 Electrostatic precipitator pilot plant. A tubular-type precipitator is used here, and a plate-type precipitator is being investigated at Croydon B power station.

BOILER AVAILABILITY

A problem connected with generation, which is being investigated in the chemical section of the laboratory, relates to boiler availability, a matter of great importance now that the " unit " system is becoming so common. This concerns the deposits which, with certain classes of coal, build up on the fire side of the heating surfaces to such an extent as to block the gas passages and to cause a shut down. The rate at which these deposits form depends on the combustion conditions in the furnace and on the pressure of certain elements, such as sodium, potassium, sulphur and phosphorus in the coal. By studying these factors the availability has been increased to such an extent that in one case boilers were enabled to steam for 3,000 to 4,000 instead of 500 hours. In another, the availability of a 525,000 lb. slag tap boiler rose from 400 hours to one year. This problem of the internal corrosion of boiler tubes is also being dealt with by studying statistical data of units in service and by carrying out investigations in the laboratory at high temperatures and pressures.

Although the thermal efficiency of power stations is gradually improving (as will be seen from figures published on page 39, *ante*) an upper limit is imposed by thermodynamic con-

* ENGINEERING, vol. 170, page 80 (1950).

siderations. It is therefore interesting to learn that the Authority is sponsoring research in universities and other organisations to investigate the possibility of converting the chemical energy of a fuel directly into electricity.

AUTOMATIC FREQUENCY CONTROL

The work of the electronics and instruments section includes the development of special instruments and the adaptation of new techniques to power system operation. In the latter field what is virtually an analogue computer has been developed to hold the power system frequency automatically at 50 cycles by continuously adjusting the generator output in accordance with the load fluctuations. In this way it is hoped to be able to maintain the frequency constant to within 0·05 cycle. Besides being of importance in connection with the cross-channel link this would incidentally improve the time-keeping of mains-operated electric clocks.

The electronics and instruments section also provides an instrument service for the laboratories. This involves the storage and maintenance of about 800 instruments. Its equipment further includes a mobile laboratory with a photographic dark room on a trailer for carrying out investigations in the field.

The equipment in the mechanical engineering section includes a 12-ton testing machine for measuring the ultimate strength of 10-ft. lengths of overhead line conductor and their associated joints. There are also a 50-ton universal machine, a 150-ton compression machine, an Izod impact tester and a hardness tester. The work carried out includes researches into conductor deterioration and the vibration of turbine blading.

FORMING COMPONENTS FROM STRIP

LARGE FOUR-SLIDE MACHINE

The four-slide strip-forming machine can be tooled for the production of a very large variety of components. It operates on the general principle of bending a length of strip progressively round a central mandrel by reciprocating slides, and can be equipped with a press ram for piercing, blanking, marking and other press operations in addition to the basic forming and cutting-off. Provision can also be made for two-stage forming where the motions of the four slides are insufficient to produce the final shape of component required. In this method of operation the component is first acted upon by all four slides, and is then moved automatically a short distance down the mandrel to a point where a second set of tools, mounted on the same slides, works the component simultaneously with first-stage working of a fresh component above. Four-slide machines have been made by Heenan and Froude, Limited, Worcester, for many years, and they have now introduced their S.207 model, which is the largest in their range, and is characterised by the high rates of production which it will achieve.

The machine is driven by a 7½-h.p. electric motor, and change gears are provided to give camshaft speeds of 40, 52, 65 and 85 r.p.m. At one component per cycle, these speeds give outputs of 40, 52, 65 or 85 components per minute, but it is possible with many types of work to multiply the number produced per stroke, and so obtain outputs in excess of the basic figure. Depending on the size and design of the components it may be possible to form them 2, 3 or 4 deep in a single width of strip.

The standard machine has two rams each of 15 tons capacity, a stock-shearing head, and four forming slides. It can also be supplied in either of two modifications; with one 15-ton ram, a toggle-press unit of 100 tons capacity with stock-shearing head, and four forming slides, or with three 15-ton rams but without stock-shearing head and left-hand slide. The maximum strip width is 2½ in. Strip up to $\frac{3}{32}$ in. can be accommodated, but the actual thickness worked will naturally depend upon the design of the component and the load required to carry out the necessary press operation.

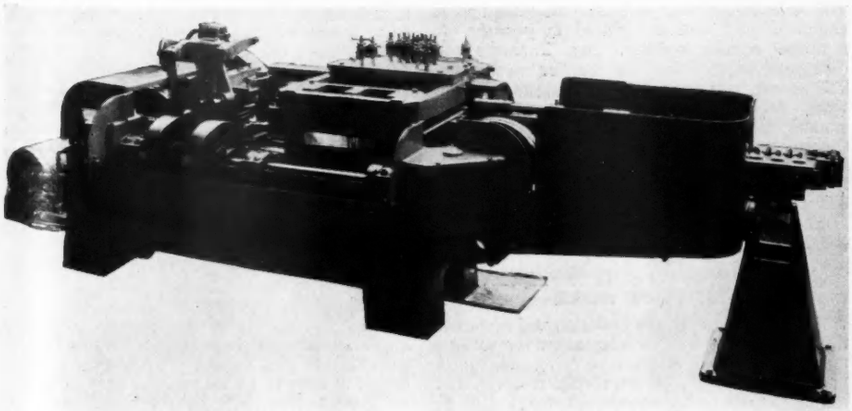
STOCK FEED

The strip stock is fed through a five-roll straightener with guide rolls in two planes and a cam and lever operated quick-release. A reciprocating gripper draws the stock through the straightener, the length of feed being adjustable up to a maximum of 14½ in. Immediately beyond the feed gripper is a stationary grip, which holds the stock while the first forming operation is performed. Meanwhile, the gripper is released automatically, and returns to its starting position to re-commence feeding. Following the first forming operation the strip is fed forward to the central mandrel, where it is acted upon by the four slides, the cut-off taking place immediately the partly-formed component is held by the first slide. The component is then formed as required, with two-stage working if necessary. Finally, it is stripped from the mandrel by a stripper with an adjustable stroke of 1⅝ in. to 3¼ in., and discharged into a chute for disposal.

The standard 15-ton horizontal ram has a die-set length of 10⅜ in., the punch and die being kept in correct relationship with each other by guide pins. The stock-shearing head is adjustable along the machine bed to suit the length of the component, and it can be adapted for a straight shear or, within certain limits, to cut a shaped end. The forming slides are steel castings, and the end of each slide is fitted with hardened steel rollers mounted on a needle-roller assembly. The maximum strokes are: front and back slides 2¾ in., side slides 4 in. Shorter strokes are possible if different cams are fitted. Each slide has an adjustable tool-block, and wearing strips are provided between the slides and slide-ways.

SIMPLE CONTROL AND SETTING

The drive to the camshafts is through a friction clutch with a control hand-lever at the front of the machine. It is thus possible to "inch" the machine for setting purposes from a point at which a clear view of the tools is obtained. A heavy flywheel is provided on the high-speed drive shaft, and the safety guard is hinged to give access to the flywheel for hand turning during setting. The cams are of case-hardened steel, and are split for easy removal and replacement. A fresh set of cams giving different strokes and dwells can thus be fitted quickly when the machine is being changed from one type of component to another. The cams are completely enclosed behind removable guards, and observation windows are provided so that the operation of the machine can be seen at any time. A limit switch is incorporated to withdraw the clutch and allow the machine to come to rest if a short feed should be delivered.



The Heenan and Froude strip-forming machine will handle strip up to 2½ in. wide, and is made in different forms to suit a wide variety of components.

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RUBBER TO RESIST HOT LUBRICANTS

Increased operating temperatures of high-speed aircraft are creating a demand for heat-resistant lubricants. An oil being developed to satisfy this demand is Turbo Oil-15, but its use creates further problems; when it comes into contact with rubber the rubber must resist it for at least 500 hours at 350 deg. F. Mr. W. J. Mueller and Mr. R. A. Clark of the Battelle Institute, Columbus, Ohio, U.S.A., have made investigations into suitable rubbers for these conditions.

The research which they directed included a study of mixtures of varying types and amounts of acrylate polymer, vulcanising agents, fillers, lubricants, and antioxidants. The most promising results were obtained with a copolymer of ethyl acrylate and chloroethylvinyl ether. The best hot-oil aged properties were found in a curing system consisting of a careful balance of triethylene tetramine, sulphur and tetramethyl thiuram disulphide. The best performing reinforcing filler was found to be a calcium silicate pigment, Silene EF. Relatively higher filler loadings and longer curing times aided in reducing rubber swell, and a small amount of stearic acid, employed as a lubricant, aided processing. The final product met all the requirements except that the swell, after the 500-hour immersion test, was 6 per cent. above the 30 per cent. maximum desired.

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INSTRUCTION COURSE IN FURNACE BRICK WORK

The City and Guilds of London Institute has prepared a two-year part-time "Final-Grade Course in Furnace Brickwork," which is intended for journeymen and apprentice bricklayers whose work is largely concerned with refractory and other brickwork in connection with the construction, maintenance, and repair of furnaces, kilns and retorts and ancillary structures.

Students entering for the course will be normally expected to have completed successfully the intermediate stage of the Institute's course in brickwork, or a course of equivalent standard. The scheme is to come into operation in the college session 1955–56 and the first examination will be held in 1956.

Further particulars may be obtained from the City and Guilds of London Institute, Department of Technology, Gresham College, Basinghall-street, London, E.C.2, price 6*d*.

COMBINATION TWO-HIGH AND FOUR-HIGH ROLLING MILL

A VERSATILE UNIT FOR RESEARCH OR PRODUCTION

Both the two-high and the four-high rolling mill have their special advantages for particular types of work. In a plant designed for large-scale production of either ferrous or non-ferrous rolled metals, both types of mill can be used in their appropriate positions in the processing layout, the large capital expenditure being justified by the high output. Where it is necessary to carry out experimental or pilot rolling, however, or where the total production may not be large, as in the case of some of the less-common non-ferrous metals such as titanium, vanadium or molybdenum, for example, difficulties arise. Experimental work is not practicable in production plants because of interference with production schedules, and the expense of laying down a large plant, either for experimental work or for small-scale production, would be too great.

The particular advantages of the two types of mill need only be summarised briefly. The two-high mill has the relatively large roll diameter necessary for ingot and billet breakdown, for reduction of high-lustre strip, and for skin-passing of annealed strip. In addition, it can be equipped with grooved rolls for producing bars, rounds and other shaped sections, which cannot be done in the four-high mill, with its small diameter work-rolls. The four-high mill, on the other hand, will produce thinner gauges with a greater degree of accuracy, and for a given material, reduction per pass and width, a decrease in work-roll diameter brings about a corresponding decrease in roll-load, rolling torque, rolling horse-power and lateral spread of strip. The latter is particularly important when rolling the harder metals and alloys, since it reduces the tendency of the edges to tear or crack.

For experimental or small-scale work it is therefore often necessary for the plant to possess the qualities of both types of mill, a condition which could hitherto only be met by the provision of at least two mills. To cater for the needs of users of pilot or small-scale plants, a combination mill, which can operate either as a two-high or a four-high, and can be changed quickly from one to the other, has been designed by the Stanat Manufacturing Company, Long Island City, N.Y., U.S.A. It is now being made under licence in this country by Albert Mann's Engineering Company, Limited, Basildon Industrial Estate, Essex.

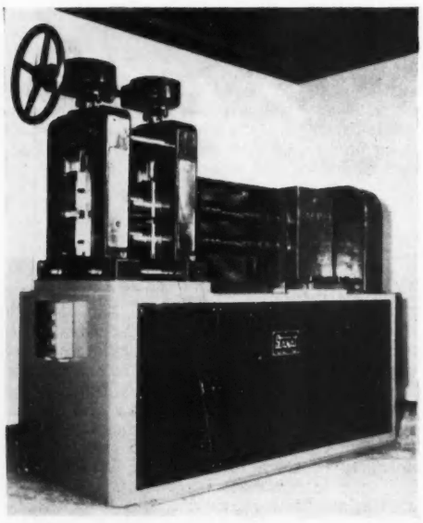

Fig. 1 The Stanat-Mann combination rolling mill can operate as a two-high or a four-high, the changeover being made quickly and easily. In its two-high form it can be used with grooved rolls, as shown here.

The Stanat-Mann combination mill is made in two sizes; 1¼ in. and 5 in. by 8 in., and 2¼ in. and 8 in. by 8 in. As a four-high mill it is therefore available with 1¼ in. diameter work-rolls and 5 in. diameter back-up rolls, the barrel lengths being 8 in., or with 2¼ in. diameter work-rolls and 8 in. diameter back-ups; the barrel lengths in this case are also 8 in. In both cases the smaller diameter work-rolls can be removed and the back-ups become the work-rolls, the mills then functioning as 5 in. or 8 in. two-high mills in the same way as the orthodox type. When operating as a two-high mill grooved rolls can be fitted in place of the flat back-ups, for bar and section rolling. Fig. 1 shows a mill set up in this way.

ENCLOSED DRIVE

The mill is carried on a fabricated steel base, which houses the drive-motor. Roll drive is through double-helical gearing, pinion stands and double universal joints operating as torque arms. The larger diameter, or back-up rolls alone are power driven, the smaller work-rolls being rotated by friction. By adopting this form of drive the smaller work-rolls are freely removable, and advantage can be taken of the larger diameter of the back-up rolls to transmit heavy rolling torques. In addition, since the smaller diameter work-rolls are interchangeable, the mill speed can be kept constant irrespective of work-roll size. To allow for the positioning of the larger diameter rolls either as back-ups or as work-rolls, the universal joints are designed to cater for an angular movement of 8 deg. in the case of the larger mill, and 9 deg. in the smaller.

The mill drive can be varied to suit the range, speed of reduction and other conditions of use as required. The standard types of drive available are: a constant-speed alternating-current motor, an alternating-current motor with a four-speed gearbox, a variable-speed eddy-current clutch, or a variable-speed direct-current motor.

UNIT ASSEMBLY OF WORK-ROLLS

The roll-housings, which are of heavy-duty, high-tensile cast iron, have machined windows of sufficient height to accommodate two pairs of rolls, and removable gibs are used for lateral location of the roll chocks. The larger diameter rolls are carried in special cage-type roller bearings which run directly on the roll necks, and can thus be removed quickly for roll changing. The smaller diameter rolls are assembled as a complete unit, and are placed in position or removed equally quickly. Fig. 2 shows the operation of inserting the smaller work-rolls. The smaller rolls can be of solid tungsten-carbide when required, the mill being particularly suitable for this type of roll, as the shape is simple, the size and weight are comparatively small, and it is not necessary to apply torsional loads to the rolls. The screw-down gear is operated by a handwheel at one side of the housing, and is equipped with a simple clutch mechanism for the adjustment of roll parallelism.

VARIATIONS TO SUIT DIFFERENT TYPES OF WORK

The basic mill is simple in design and construction, and lends itself to adaptation for various types of work. In addition to being capable, in its standard form, of both cold and hot flat rolling up to a temperature of 1,000 deg. F. and bar and section rolling as a two-high mill, it can be equipped with a self-contained system for heat dispersion. This circulates, cools and filters the bearing lubricant. Water can be circulated through cavities in the rolls when necessary. For rolling certain light gauge metals such as molybdenum, which should be reduced at about 300 deg. F., a heated fluid can be circulated through the roll cavities instead of cooling water. The mill can be used in conjunction with various types of pay-off and coiling reel and tension devices, and for laboratory use it can be equipped with means for indicating rolling torque and roll loading.

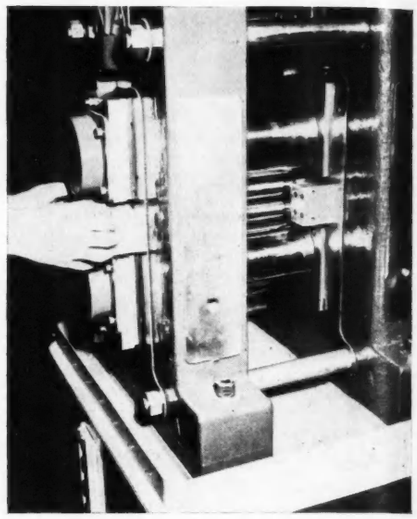

Fig. 2 To convert the two-high mill to a four-high, the screw-down gear is opened, and the smaller work-rolls are inserted as a completely assembled unit.

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AIR STARTING FOR SMALLER DIESELS

A compressed air system for starting two or four stroke Diesel engines of up to 20 b.h.p. per cylinder output and up to eight cylinders has been introduced by The Hymatic Engineering Company Limited, Redditch, Worcestershire. The system comprises a compressor, air receiver, stop valve, distributor, and directly operated injector valves. Air is fed from the air receiver at an operating pressure of 450 lb. per square inch through the stop valve to the distributor, which is driven either by the engine crankshaft or camshaft. In four stroke engines the injection period is from 10 to 45 deg. and in two-stroke engines from 10 to 80 deg. after top dead centre.

The distributor has a rotor which consists of a flat plate with a hole drilled near the periphery. This hole registers in turn with each of the ports leading to the various cylinders. When the stop valve is opened, this rotor is forced into direct contact with the ports and at the same time an effective driving shaft seal is made. In this way air is admitted to that cylinder in which the piston is just past top dead centre on the working stroke and the initial turning moment is obtained. As the engine turns air is passed into each cylinder in turn until starting speed is reached.

High quality cast iron is used for the distributor body and graphited sintered iron for the rotor. This means that during starting, when the lapped faces of the distributor are in direct contact, friction and power consumption are reduced to the minimum. Under normal running conditions the faces are not in contact.

The injector valve devised for this system has approximately the same dimensions as a normal car sparking plug so that provision for it in the design of a small Diesel cylinder head can easily be made. The body of the valve, which is known as the Hymatic type IV.5/1, is made of phosphor bronze, and the spindle is of EN.58A high quality steel.

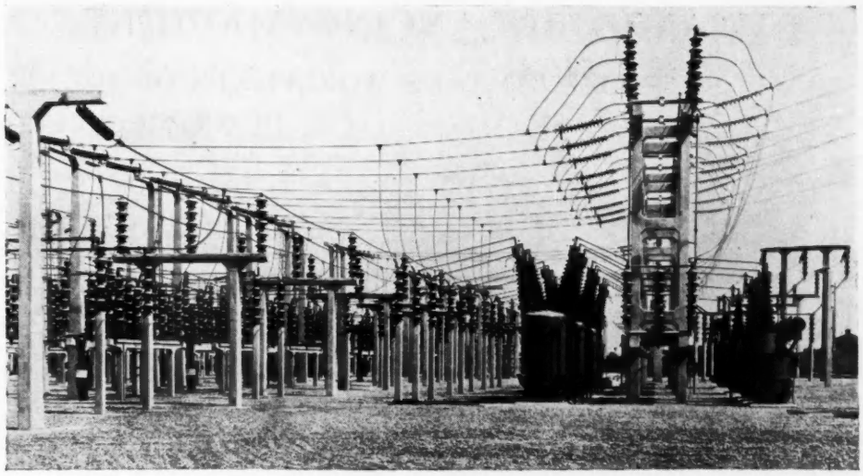
132-KV SUBSTATION AT CASTLE DONINGTON

The first section of the Castle Donington 132-kV Grid substation of the Central Electricity Authority was recently energised by means of a new 5½ mile long overhead line which was looped into one of the existing Nottingham to Coventry feeders. This section has been commissioned to enable a works supply to be given preparatory to the opening of the new Castle Donington power station, of which the first 100-MW set is expected to begin production towards the end of this year. In the immediate future, other 132-kV circuits radiating from the substation will be energised.

As will be seen from the illustration, Castle Donington substation is of the low double bus-bar type and is divided into three sections, the reserve bars being in the form of "horse shoes," with the circuits back to back. This type of layout reduces the overall length of a normal double bus-bar station by about 50 per cent., but even so the length of the station is 800 ft. The enclosure covers an area of 5½ acres and when complete there will be approximately 3½ miles of overhead copper connections and bus-bars.

The substation will be equipped with 20 oil circuit-breakers controlling three 100-MW generators, two 120-MVA 275/132-kV auto-transformers, two banks of two 10-MVA 132/3·3-kV station transformers, three bus-couplers, two bus-sections, six feeders and a reactor.

To avoid the reserve bars of the centre section having to cross the main bus-bar with overhead connections, a short length of 132-kV 0·6 square inch cable, two circuits per phase, has been incorporated in the bars. The first and third sections of the bars are coupled through a 90-MVA reactor, which has been installed to limit the fault level to the rupturing capacity of the 3,500-MVA bulk oil circuit-breakers. These were manufactured by the British Thomson-Houston Company, Limited, Rugby, and are pneumatically closed and spring opened.



View from the north-west corner of Castle Donington substation showing line entries, voltage transformers, oil circuit-breakers, isolators and overhead connections.

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CENTRALISING INFORMATION FROM REMOTE SOURCES

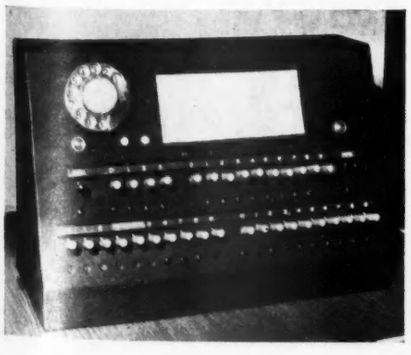
System for Cash Registers

A system of cash registers which provides a means of transmitting details of transactions to a central control unit has been developed by Rentrix, Limited, and was recently demonstrated at their offices at 16 Grosvenor-place, London, S.W.1. Each cash register shows the amount of the purchase in the usual way, and in addition it is wired through control apparatus to a consulting unit. The consulting unit is fitted with a switch for each cash register, and would normally be installed in an executive's office. By depressing the appropriate key he can see the running total for any particular cash register, for any combination of registers or for all the registers in the system.

By using a private pair of telephone wires the system can be extended throughout the country so that an executive of chain or multiple stores can sit in the head office and at the flick of a switch know what is happening in any store or on any cash register. An optional addition to the cash registers is a number of dissecting buttons. These are depressed after the monetary keys are used, and will denote a type of transaction—cash, credit, hire purchase, etc.—and this information is stored in the control apparatus until required. The consulting unit can then show not only how much cash has been taken at any register or combination of registers, but how much was credit or hire-purchase transactions, and so on. If necessary there can be more than one consulting unit, at each of which all the information is available.

The principles of the cash registers can also be applied to statistical work. Information is fed into a control unit from a number of remote points, and consulting units will give the centralised and co-ordinated information to those needing it. On the prototype unit shown in the accompanying illustration there are sufficient switches to analyse 3,999 different items. When the appropriate switches for a particular number are depressed the quantity of items stored or removed under that number—according to whatever system is used—will come up in the panel to the right of the telephone dial.

Most of the components used in the system are standard telephone components, which make it both economical and reliable, and all circuits are fully checked and guarded.



This prototype statistical unit can show the number of items registered under each of 3,999 headings. Information can be fed into the unit from any number of remote points.

LORRY WITH EXTRA-WIDE TYRES

Use of Twin Engines

The cross-country vehicle shown below incorporates the Straussler-Lypsoid wide track tyres, and is made by Nicholas Straussler and Company, Limited, 5 Clarges-street, London, W.1. It has twin four-cylinder engines which can be either petrol or Diesel; total h.p. developed is either 150 or 180 in the case of petrol engines or 90 or 120 with Diesel engines. There are five forward speeds and one reverse, and the two-speed transfer box doubles this number of gears; the maximum speed is 50 m.p.h. Drive is either to all four wheels or to the rear wheels only, or alternatively the engines can drive the winch. Either of the engines can be disconnected if not required, and when travelling along normal roads one engine can be disconnected to save fuel.

The engines are set well forward to increase load-carrying space. Ground clearances are high, 18 in. midship, and both approach and departure angles are high enough to tackle sharp banks. The Straussler-Lypsoid tyres, which were described in ENGINEERING for December 24, 1954 (vol. 178, page 832), are 44 in. in diameter and 28 in. wide. They are inflated to only 10 lb. per square inch, and owing to their low period of oscillation they act as soft springs of great amplitude adding some 6 in. to the spring range and providing good springing with practically no unsprung weight. The rated load of the vehicle is 2 tons for military and 5 tons for commercial purposes. The weight unladen is 4 tons, including body and cab, and ground pressure at 6 tons all-up military weight is 4·5 lb. per square inch.

This twin-engined lorry can have either Diesel or petrol engines. The 28-in. wide tyres give exceptional performance over rough ground, and with a 2-ton load the ground pressure is only 4·5 lb. per sq. in.

DYNAMIC BALANCING MACHINES

RANGE EXTENDED TO TAKE WORKPIECES OF 100 LB.

The range of dynamic balancing machines now being made by Dawe Instruments Limited, 99 Uxbridge-road, London, W.5, has been extended by the addition of model 1252 which will take work weighing up to 100 lb. and as much as 40 in. long. The sensitivity is such that rotors of this weight can be balanced to within 0·0064 in.-oz. Dimensions of the standard machine shown in the illustration are 45 in. by 31 in. by 56 in. high; the weight is approximately 8 cwt.

The machine frame consists essentially of two solid end plates of heavy-gauge steel connected by five large-diameter round bars (three at the top, two at the bottom). All other parts (the electrical-gear cabinet, the control box, the bearings and the indicating meter) are clamped on to these bars. The position of any part can thus be adjusted to suit requirements, although the arrangement shown in the illustration is the most usual. The fuse box and the mains switch are mounted on the inside of the right-hand side plate. The stroboscope lamp, which is universally adjustable, is mounted on the left-hand side. The connecting cables are held in position by cable clips.

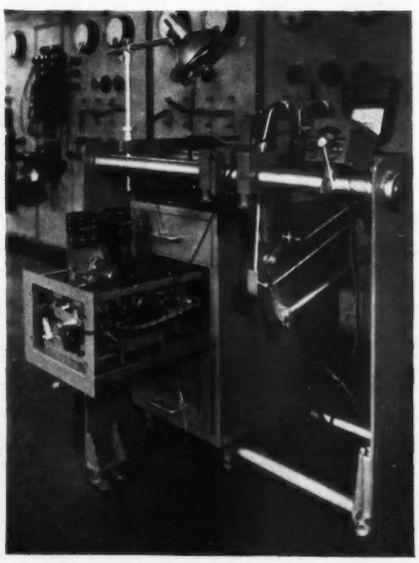
The rotor to be balanced runs in two horizontal half bearings carried on cradles by flat springs. The cradles are mounted on two rigid tie bars clamped on the framework crossbars, so that their position may be adjusted to take any length of rotor within the capacity of the machine.

The component is rotated by a built-in three-phase synchronous electric motor by means of a flat woven belt. To facilitate loading and unloading, the belt can be lifted off the component by the movement of a single lever. This raises two arms bridging the workpiece which in turn lift the belt. Two flexibly mounted idler pulleys provide enough movement for a space of between 6 and 12 in. all round the workpiece when the belt is raised. These pulleys also enable the belt tension to be adjusted by varying the loading.

When the component is being rotated by the belt, any unbalance is detected by two moving-coil pick-ups and indicated on the meter at the rear of the machine. The electrical mixing circuits ensure that corrections made in one plane do not affect the readings of the other. Setting-up is carried out by running a balanced rotor on the machine and introducing on it a slight out-of-balance force at each plane in turn. This enables the zero compensation to be made on the control panel and the meter calibration set to give a direct reading. Once set, the adjustment controls can be covered by a panel through which the Bowden cable for the remote control passes.

The operational control box can be seen in the illustration, mounted on the right of the top cross-bar. Movement of the lever from the off position to either left or right starts the driving motor and connects the circuits for the side chosen. If desired, the hand lever can be replaced by a foot switch. The angular position of the unbalance is shown by a pointer which is illuminated by the stroboscopic lamp. The latter is triggered from the pick-ups to show the point of greatest vibration. Indication on the rotor itself can be done by marking the segments, for example by sticking a piece of numbered adhesive tape around it. The machine is resiliently mounted to eliminate external vibrations.

For ease of maintenance, rack mounting has been used for the electronic components. As far as possible all circuits have been grouped into sub-assemblies which can be unplugged and removed for servicing. The power supplies are stabilised rendering the operation independent of mains variations. An electromagnetic brake brings the motor to rest very quickly.



With a capacity for a workpiece weighing 100 lb., and as much as 40 in. long, the model 1252 machine can detect an out-of-balance force of 0·0064 in.-oz.

MANUFACTURE OF DUCTILE IRON

MAGNESIUM ADDITION IN A CLOSED VESSEL

The manufacture of magnesium-treated ductile, or spheroidal graphite iron, which is carried out under licence from the Mond Nickel Company, Limited, involves the addition of small quantities of magnesium when the iron is molten. The difficulties of doing this with metallic magnesium are obvious, and they have been overcome by the use of nickel as a "carrier." A new method of making the magnesium addition was demonstrated recently by Lloyds (Burton), Limited, at their Burton-on-Trent foundry, where the S.K.B. ladle is in use.

By this technique the magnesium is added to the molten iron by means of a closed vessel which is actuated by compressed air. The iron is first prepared in an electric-arc furnace by melting down selected mild steel, and recarburising it to iron by the addition of crushed electrodes. A pure cast iron, with a carbon content of 3·5 per cent., and free from sulphur and other undesirable elements, is thus produced. This metal is poured into the pressure vessel, which resembles an orthodox ladle but is provided with means for closing the mouth. The vessel is then placed on a flanged-wheeled trolley and run on a rail track into a small chamber built on to the outside wall of the foundry. Steel doors are provided between the chamber and the foundry. Inside the chamber the trolley and ladle are centred below a compressed-air plunger carried from the roof, and having at its lower end a tubular steel container for the magnesium. This container is screwed into position, and a refractory sleeve is used to protect the lower part of the plunger, which will be in contact with the molten metal. Above the sleeve there is a flange on the plunger which, when the plunger is lowered, makes contact with the top of the pressure vessel and so seals it. An asbestos-graphite washer is placed in position on top of the pressure vessel before it is run into the chamber, to ensure that the seal is complete.

As soon as the pressure vessel is in position in the chamber, the doors to the foundry are closed. The operator, who is outside the chamber, but can see the vessel through a small glazed window, then opens the air valve controlling the plunger, which drives the magnesium container down into the molten metal. The steel container is melted away, but before the magnesium is released as a result of the melting, the top of the vessel is closed by the flange on the plunger. The actual addition of the magnesium is thus made under fully-closed conditions. Up to 12 lb. of magnesium can be added in this way to the molten iron. The quantity added is in excess of that required, and the iron is then poured into a ladle containing untreated iron, which dilutes the treated metal to give the final residual magnesium content required. By this means a relatively small pressure vessel can be used to prepare a large quantity of treated iron. Inoculation of the iron is carried out simultaneously with the dilution, and the metal is then ready for the pouring of castings in the normal manner.

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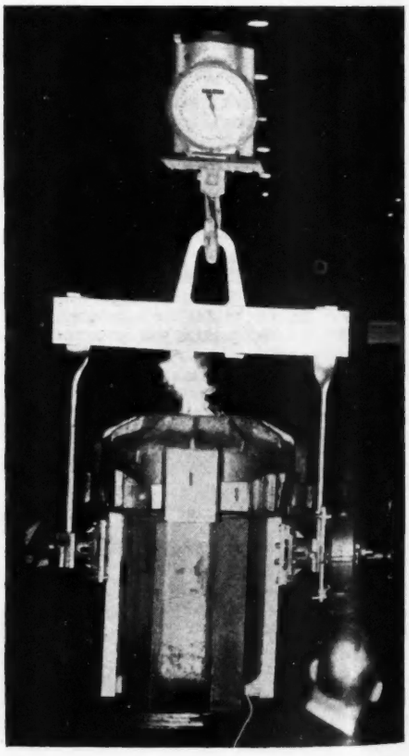
WHEEL PULLERS

The "Kukko" range of pullers for removing wheels and bearings that is now being made by E. F. Allchin and Company, 137 High-street, Aston, Birmingham 6, includes both mechanical and hydraulic-pressure models. Three-arm types have capacities up to 25¼ in. diameter with a depth of grip of 8 in., and a two-arm model has a capacity of 30 in. diameter with a depth of grip adjustable from 16 in. to 27½ in. The arms can be reversed for internal or external use.



The S.K.B. ladle, as used by Lloyds (Burton), Limited, for the addition of magnesium to molten iron, is a closed vessel; the magnesium is charged by a pneumatic plunger.

THE GASIFICATION OF HEAVY FUEL OIL

PROPOSED SOLUTION OF FURNACE PROBLEMS

The " Office Central de Chauffe Rationnelle " (Central Organisation for the Economic Use of Fuel), an association formed in France by a number of industrialists with the support of public bodies, has invented a process and developed the necessary equipment for the gasification of liquid fuel. There are already about 100 of these gasifier installations in operation on the Continent and a licence has been granted to the Wellman Smith Owen Engineering Corporation, Limited, Parnell House, Wilton-road, London, S.W.1, for their manufacture and sale in Great Britain and the Commonwealth countries. A pilot equipment has been installed at the Darlaston works of the Corporation for demonstrating the process to those interested.

FLAME AND FURNACE CONTROL

As is well known the heating of furnaces often presents problems relating to flame length and formation, temperature distribution and the nature of the furnace atmosphere. A great advance towards the solution of these difficulties, particularly the nature of the furnace atmosphere, is achieved by the combustion of the resultant products from the gasification of liquid fuel. The combustion of gasified fuel oil may, in fact, be said to have all the advantages of gas firing, such as ease of flame control and furnace atmosphere. At the same time it retains the inherent superiorities of the use of liquid fuel—ease of handling and lower labour costs.

The combustion of gasified fuel oil takes place in two steps, the first being gasification by the application of primary air and the utilisation of the heat of some of the constituents thus produced. The second is the combustion of the resulting gas and finely suspended carbon matter by a supply of secondary air at the furnace.

SWIRLING OF OIL-GAS MIXTURE

The gasifier, which is illustrated in Fig. 1, consists of a small vertical cylindrical shaft, into the base of which oil and primary air tuyères are introduced as shown in Fig. 2. These tuyères are arranged at the periphery of the gasifier in such a way as to impart a circular swirling motion to the mixture of oil and gas. Oil is fed to the gasifier from a constant oil-level tank situated above the equipment as shown in Fig. 2. The pressure in this tank is maintained at that prevailing in the primary-air ring main and thus causes oil to be supplied to the gasifier through a calibrated orifice in the oil feed pipe in direct ratio to the primary air pressure which is generated by a fan. With this arrangement, the oil/air ratio is kept constant for any given primary air pressure and pre-set orifice diameter. The products of this process leave the top of the equipment through a refractory-lined tube and are led to one or more burners for combustion with the secondary air in a furnace adjacent to the gasifier.

All types of fuel oil, including heavy fuel oils, can be used in the gasifier, provided that the oil, before being supplied to the constant-level tank, is heated to a temperature sufficient to give it a viscosity of 100 deg. to 150 deg. Redwood No. 1.

A period of about half-an-hour is required to start the gasifier from cold. This is sufficient to heat up the equipment to the necessary oil cracking temperature, after which it is possible to operate it and the burners at normal full load.

During operation about 2 to 4 per cent. of the oil gasified (depending upon the nature of the fuel used) is deposited in the form of coke at the base of the gasifier. This deposit takes only a few minutes to remove, after 6 to 8 hours operation, and consequently causes no appreciable drop in the furnace temperature. In the case of small-capacity gasifiers, the primary and secondary air can be supplied from one fan. For larger-size gasifiers, it is preferable to use two fans, as shown in Fig. 2, since the primary air is supplied at a higher pressure than the secondary air.

The products of the gasification depend mainly on the air/oil ratio. The higher this ratio the lower the resultant calorific value of the gas and the higher the temperature of the products leaving the gasifier. With a lower air/oil ratio, the calorific value rises and the outlet temperature falls, but, owing to the lower cracking efficiency, the amount of non-gasified suspended carbon increases. The final results of combustion are not, however, affected to any great extent owing to the fact that the final temperature is a product of the latent and sensible heats of the gas. Including the amount of suspended carbon, which is equivalent to about 30 per cent. of the carbon in the oil, the overall thermal efficiency is from 95 per cent. to 98 per cent.

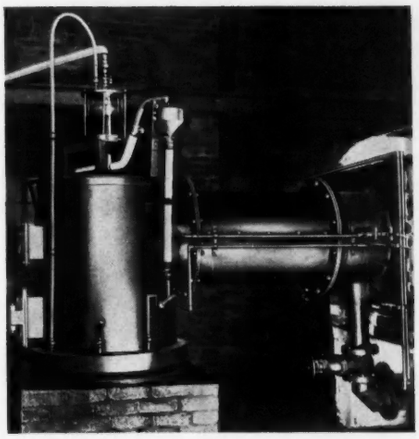


Fig. 1 The heavy-oil gasifier which has been designed in France to improve firing conditions, and is in effect an oil cracking plant.

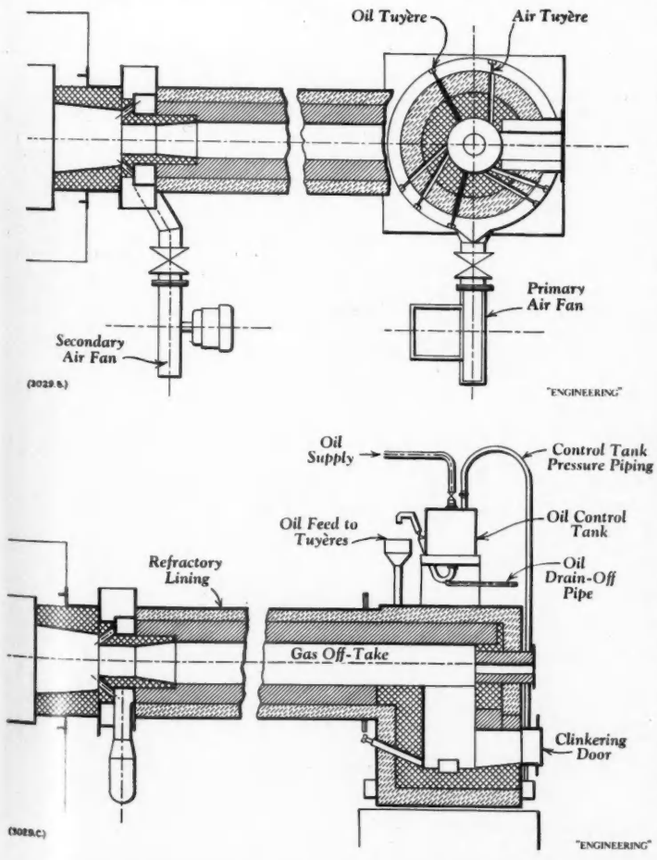


Fig. 2 Constructional details of gasifier. This system is said to have the advantages of gas firing, including control of flame length and furnace atmosphere, which can be slightly reducing, neutral or oxidising.

" OIL CRACKING PLANT "

As will be gathered the oil gasifier is not a gas producer in the normal sense, but an oil cracking plant. There is therefore a fundamental difference between the process in this equipment and that in a conventional gas producer. The latter when using coal as a fuel has a cold-gas thermal efficiency of from 65 per cent. to 70 per cent. and a hot-gas thermal efficiency at the point of combustion of 75 per cent. to 80 per cent. On the other hand, the losses from a heavy fuel-oil gasifier amount to only 2 per cent. to 3 per cent. from radiation and from 1 per cent. to 2 per cent. from the coke deposited. The composition of the gas and the outlet temperature from the gasifier vary with the air/oil ratio.

The amount of primary air used in the process is approximately one third of the total air required for combustion of the oil or about 60 cub. ft. per pound of fuel oil gasified. For an orifice of pre-set size the air/oil ratio remains constant and the rate of gasification is therefore entirely dependent on the primary air pressure. For a different air/oil ratio, a different diameter of orifice must be used. This operation can, however, be carried out in a few minutes.

ANALYSIS OF GAS PRODUCED

The approximate analysis of the gas produced is: carbon dioxide, 4 per cent.; carbon monoxide 16 per cent.; hydrogen, 14 per cent.; methane, 4 per cent., and nitrogen, 62 per cent.; the temperature of the gas being in the region of 1,150 deg. to 1,250 deg. C. The heating value of the gas is made up as follows: net calorific value, 120 B.Th.U. per cub. foot at normal temperature and pressure; sensible heat content, 50 B.Th.U. per cubic foot, and heat in suspended carbon, 45 B.Th.U. per cub. foot; the total heat value at the producer outlet being 215 B.Th.U. per cub. foot.

These fuel-oil gasifiers can be supplied in varying capacities, ranging from 6 gallons to 250 gallons per hour. The smallest model is about 3 ft. and the largest about 6 ft. in diameter. Under normal conditions, the gasifier would have a turn-down range to 25 per cent. of its full capacity, but if specially required it could

be arranged to have a turn-down of ten to one by modifying the tuyères.

REDUCED SULPHUR CONTAMINATION

This type of oil gasifier has already been installed in about 48 metallurgical furnaces on the Continent. It is claimed that, compared with the conventional burner, it has the advantage of flexibility, being capable of creating a furnace atmosphere which is slightly reducing, neutral or oxidising. This flexibility is not possible with an orthodox atomising type of oil burner, which cannot be operated without 15 per cent. to 20 per cent. of excess air. Furthermore, the normal atomising type of oil burner (however effective the atomisation of the fuel may be) invariably produces droplets, the deposition of which on the material being heated may be the cause of sulphur contamination. It is claimed by the inventors of this process that in the case of combustion of gasified fuel oil, the sulphur attack is less than that from an orthodox burner. Tests are at present being carried out in conjunction with oil companies in this country to confirm this claim.

It may be mentioned that although Fig. 1 shows the gasifier feeding one burner only, a furnace may be equipped with a number of burners supplied from one gasifier. In that case such burners would, of course, be designed to meet the requirements of the particular heating process.

BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

Continued from page 796 (*vol.* 179)

The control of furnaces and industrial processes; the measurement of oxygen concentration, liquid flow, pressure and temperature; the investigation of sheet, tube and strip materials for thickness variation; and the testing of fabrics for stiffness and crease resistance are some of the subjects covered in the continuation of our report on the British Instrument Industries' Exhibition. The Exhibition, which was held at Earls Court, London, opened on Tuesday, June 28, *and closed on Saturday, July* 9.

FLAME-FAILURE UNIT

Liquid-level control units; process and cyclic timers; items of photo-electric apparatus; proximity switches; and flame-failure and ignition programming equipment were displayed by Elcontrol Limited, 10, Wyndham-place, London, W.1. They also exhibited a withdrawable chassis, to be used for all but their smallest control units, which plugs into a steel case and thus simplifies installation. Among the proximity switches shown was the model CR3, which has been designed for use on ash hoppers, coal bunkers and other heavy industrial duties. The photo-electric equipment included two-way registration controllers for such applications as the synchronising of cross-cutting with printed design.

Three kinds of single-stage electronic liquid-level control unit are now made by Elcontrol, in addition to a standard double unit. This combines the functions of two single units and may be used, for example, to give pump control or high- or low-level alarm. An especially sensitive model is built for use with liquids of low conductivity. A number of probe fittings for liquid-level control were also displayed, one of which is designed for use in pressurised vessels built to operate at comparatively high temperatures.

An item of particular interest was the Elcontrol FS9M flame-failure and ignition-programming unit, which employs an infra-red sensitive cell and responds to the modulated radiation emitted by all flames both luminous and non-luminous. This equipment is fully automatic and can be used with any gas or oil firing appliance. It provides safe automatic ignition on lighting up, immediate fuel cut-off on running flame failure, and automatic lock-out on fuel-supply failure. Elcontrol were also exhibiting a variety of other control equipment of this kind suitable for use both with burners employing manual ignition and with fully automatic plant. Fig. 6 shows the interior of an Elcontrol FSM1 flame-failure unit, which may be used with either manual or automatic ignition.

THICKNESS GAUGES

Among the items exhibited by Baldwin Instrument Company, Limited, Brooklands Works, Dartford, Kent, were a combined moving-coil micro-ammeter and film-strip projector designed to give a magnified image of the scale and pointer on a screen; an "Atomat" beta-ray thickness gauge; instruments for measuring the "dose" received by personnel subjected to radiation from gamma isotopes or X-ray units; a meter for investigating the moisture content of grain, cocoa, coffee, peas and other hygroscopic commodities; a static-electricity charge detector for use with such materials as paper, plastics, rubber, explosives and petroleum; and several instruments for light colour and quantity measurement. A transverse-profile unit and a tube-wall thickness gauge were also shown.

Flat plates and tubes having diameters from 2 in. upwards may be examined by means of the Baldwin tube-wall thickness gauge, which makes use of the back-scattered gamma radiation from a source placed against the outside of the tube.

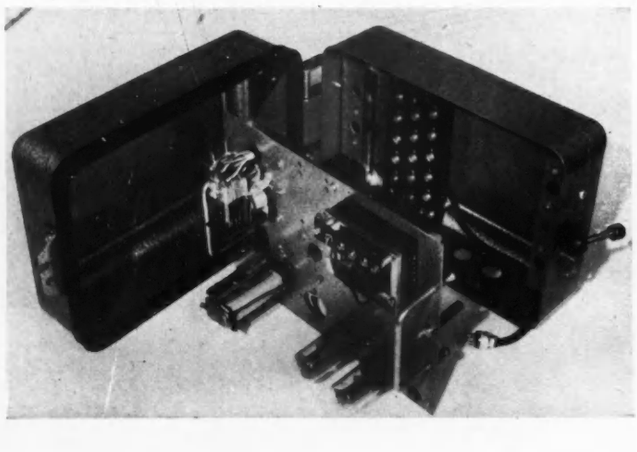


Fig. 6 The Elcontrol FSM 1 flame-failure unit provides immediate fuel cut-off on flame failure of oil or gas burning equipment. It employs an infra-red sensitive cell and ensures furnace safety during ignition and subsequent running.

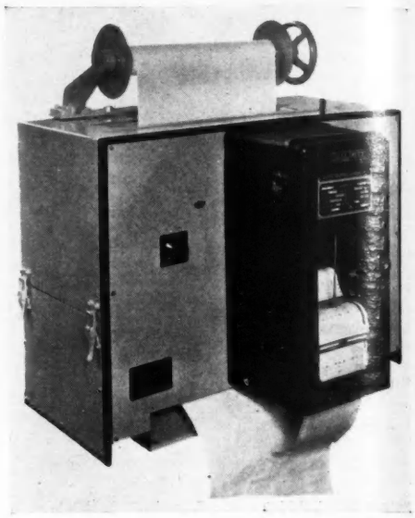


Fig. 7 The Baldwin transverse-profile unit, which is basically a beta-radiation thickness gauge, records variations in weight per unit area across a strip of paper, plastics or other material.

A technique for distinguishing between radiation back-scattered from the tube wall and radiation falling directly from the source upon the detector makes the equipment extremely local in application.

In principle, the Baldwin transverse-profile unit is similar to the same company's Atomat thickness gauges, in which beta radiation, consisting of fast electrons from a radioactive source, is directed at the sheet of material under examination. Part of the radiation is reflected or scattered, another part is absorbed, and a third part, within limits set by the weight per unit area and atomic number of the material, passes through the specimen. The transmitted radiation falls on a detector and the resulting ionisation current, after amplification, serves to indicate the weight per unit area of the sheet.

It is frequently necessary to record the variation in weight per unit area across a strip of paper or plastics, say, and the transverse-profile unit has been developed for this purpose. In practice, the machine operator cuts off a strip of material about 12 in. wide across the end of a reel, and this is then placed in the unit. Closing a switch causes the strip of material to be fed through automatically, and variations in weight or "level" across the sheet are immediately

Fig. 8 The Shirley combined creasing and stiffness tester is one of the instruments developed by the British Cotton Industry Research Association which are being made commercially by Shirley Developments, Limited.

indicated and recorded. The instrument is shown in Fig. 7 fitted with a recording unit made by Elliott Brothers (London), Limited, Century Works, London, S.E.13.

CREASING AND STIFFNESS TESTER

The principal aim of Shirley Developments, Limited, 40 King-street West, Manchester, 3, is to make available to British Industry the machines, instruments and processes invented and developed by the Shirley Institute—the British Cotton Industry Research Association. Such problems as the accurate measurement of viscosity, flexibility, moisture content, kinetic friction and the elimination or control of "static" (charges of static electricity) have been dealt with, and some of the commercial instruments resulting from this work were shown on the company's stand.

One of these was the Shirley combined creasing and stiffness tester designed to measure easily and accurately the creasability or crease-resistance and the stiffness of fabrics. Shown in Fig. 8, this instrument provides a definite and standard measurement so that a fabric may be universally specified and indication given of such not easily defined characteristics as "draping" and "handling" quality, fullness and finish.

The instrument, as can be seen from Fig. 8, is simple in construction and the stiffness characteristic is obtained from a standard strip of test material in terms of the angle in degrees through which a given length of it droops under gravity. Conversely, the crease resistance of a fabric is found by doubling a specimen piece and observing the extent to which the sample opens out again. Determination of the "bending length" provides an important factor in draping quality; "flexural rigidity" is a measure of handling character; and the "bending modulus," derived from flexural rigidity and thickness, is an indication of fullness or paperiness. Apart from their use in quality control all these measurements are of value in fabric design.

OXYGEN METER

An oxygen meter which its makers claim can readily detect changes in oxygen concentration of half a volume per million was one of the items exhibited by Hanovia (Lamps Division of Engelhard Industries, Limited), Slough, Bucks. In addition were shown a photo-chemical reactor (10.L) designed for laboratory use, or even as a small-scale production unit, for the preparation of compounds by means of ultra-violet or visible radiation; a short-wave ultra-violet meter; various bactericidal units and water sterilisers; and a "Chromatolite" fluorescent lamp, in which short-wave ultra-violet rays at 2537 A.U. are applied to the examination of chromatograms and to fluorescent investigations in general. Also on display were a range of portable and laboratory fluorescence lamps for use in crack detection in metals and plastics, ageing and fading, polymerisation and mineral selection, and various other applications.

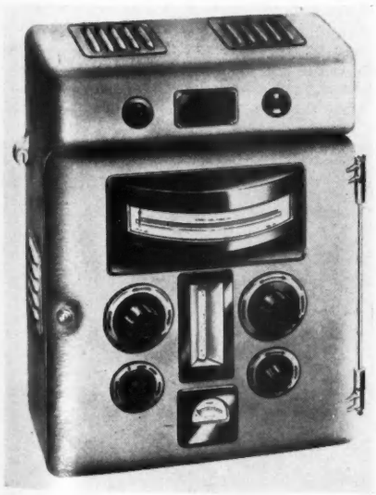


Fig. 9 Developed by Engelhard Industries, Limited, the Hersch oxygen meter can detect changes in oxygen concentration of half a volume per million and is continuous in action.

The short-wave ultra-violet meter was developed for measuring radiation from the low-pressure type of mercury discharge lamp, although interposition of an attenuator grating permits its use close to tubes of relatively high output. The indicating meter dial can be detached from the main assembly during use so that the operator can take readings without being exposed. The complete instrument is 8 in. wide by 7 in. deep by 8½ in. high.

The Hanovia bactericidal units are made for suspension or wall mounting and are capable of destroying the bacteria or viruses of such air-borne diseases as common colds, pneumonia, diphtheria and tuberculosis by irradiation from a quartz mercury discharge tube. Both manually and automatically operated water sterilisers are built using ultra-violet radiation to destroy all forms of bacteria, fungi and viruses present in water without changing its composition or taste.

Developed by the Baker Platinum Division of Engelhard Industries, Limited, the Hersch oxygen meter can measure continuously traces of oxygen present as an impurity in other gases. It covers the range 0 to 100 volumes per million and at maximum sensitivity, the full-scale deflection on the 10-in. scale of the meter represents 10 volumes per million, so that changes in oxygen concentration of only half a volume per million can be detected.

The accuracy of the indication is claimed to be less than plus or minus 5 per cent. of full-scale deflection and the response of the instrument to changes in oxygen concentration is almost instantaneous. The Hersch oxygen meter should be useful in many metallurgical and chemical processes where the maintenance of an oxygen-free atmosphere is essential. The instrument, which appears in Fig. 9, measures approximately 24 in. high by 18 in. wide by 12 in. deep.

PACKAGED PROCESS CONTROL

The principal exhibit shown by Short and Mason, Limited, Aneroid Works, Hale End-road, Walthamstow, London, E.17, a subsidiary of the Taylor Instrument Companies, U.S.A., was a new range of instruments forming the "Transet" control system. This three-part system consists basically of pneumatic force balance transmitters, receivers in the form of recorders or indicators and stack-type controllers.

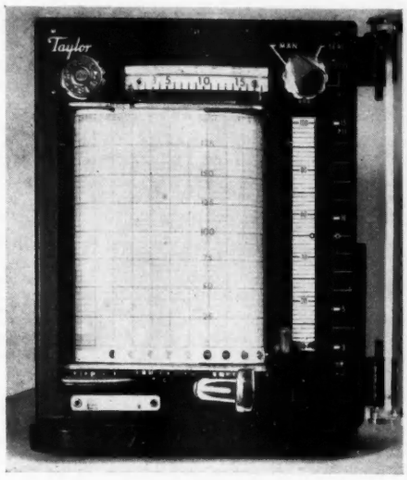


Fig. 10

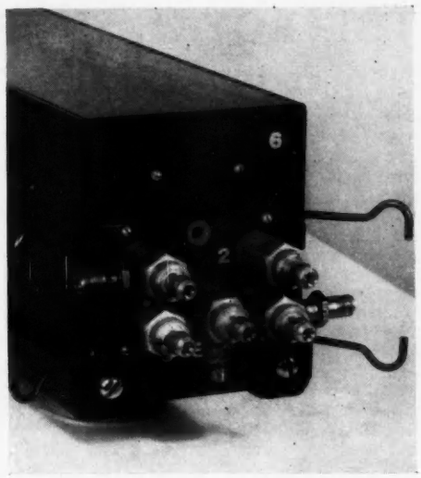


Fig. 11

Front and rear views of the Taylor "Transet" recording receiver exhibited by Short and Mason. In the Transet control system, each instrument is an interchangeable plug-in unit; several may be mounted in the flow diagram of a process to form a graphic control panel.

A particular feature of this range is the packaged plug-in design of all the component units. In addition were displayed various other instruments for the indication and control of temperature, liquid-level, flow, pressure, humidity and similar quantities, and including the Taylor "Fulscope" controller mechanism, which by means of interchangeable components can be arranged to give numerous kinds of control. A combined filter and regulator, a range of flameproof pressure switches and a recently produced time cycle controller were also shown.

The Transet control system incorporates a number of interesting features. The temperature and pressure transmitters are capable of measuring short range spans at elevated temperatures and pressures, and accuracy is expressed as a percentage of the span. An optional component in the temperature transmitter enables a rapid speed of response to be attained by compensating for the thermal lag of the measuring element. The range of any transmitter may be easily varied. Receivers, whether indicators or recorders, are all interchangeable and as compact package units form the basis of graphic control panels, where they may be mounted in the flow diagrams of processes.

This plug-in feature of the Transet receiver offers considerable versatility, and front and rear views of the instrument are shown in Figs. 10 and 11. The unit is compact, permits manual or automatic operation, has remote set-point adjustment and embodies a continuous valve-position indicator. Thirty-day or 24-hour strip chart with three hours visible may be used and either electric or pneumatic chart drives can be fitted.

To be continued

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DRAWING BOARD WITH PARALLEL MOTION

A parallel motion that can be fitted to any standard drawing board has been produced by the Angula Engineering Company, Glaskin-mews, Pembury-road, London, E.5. One of the advantages claimed for it is that there are no projections behind the board and the latter can therefore be used on a flat horizontal surface. A double parallel straight edge takes the place of the Tee-square and is guided in its movement on the board by spring-tensioned wires which extend round the sides and top edge. The guide rollers run on ball races for ease of movement. Models for all standard board sizes are available and can be supplied either complete with a board or as a set of parts for fitting.

THE ROYAL SHOW AT NOTTINGHAM

Concluded from page 30

At the Royal Show at Nottingham, which ended on July 8, 620 exhibitors displayed every type of machinery and equipment used by the modern farmer, large or small, mixed or specialist, domestic poultry and pig keepers, horticulturalists and gardeners. There were nineteen entries for the R.A.S.E. Silver Medals, awarded for implements or machines adjudged to be new in principle or purpose. Among these were the County four-wheel drive tractor, which was described in ENGINEERING for December 24, 1954 (vol. 178, page 834), the David Brown traction control unit (December 17, 1954; vol. 178, page 802), mechanical pick-up hitch by Taskers of Andover (July 16, 1954; vol. 178, page 94), "Silo-aid" by Atkinson's Agricultural Appliances (January 7, 1955; vol. 179, page 30), and the Massey-Harris-Ferguson kale cutrake, described below.

REDUCTION GEAR AND LIVE POWER TAKE-OFF

On the stand of Massey-Harris-Ferguson (Manufacturing), Limited, Fletchamstead Highway Coventry, was the Ferguson combined epicyclic reduction and live power take-off unit. The unit, shown in Fig. 6, fits between the transmission and rear-axle centre housings of all TE and TO type Ferguson tractors, and extends the overall length by about 5 in. It permits the tractor to be used with the standard range of gears and fixed power take-off, or with all speeds reduced by 3 : 1 and live power take-off; the latter arrangement means that the tractor can be stopped without interrupting the rotation of the power take-off.

The two levers which operate the unit are the selector lever (shown in the vertical position with a round knob on top, the lever nearest the back of the unit housing), and the brake lever (just forward of the selector lever, and shown in a nearly horizontal position). When the levers are in the positions shown the drive from the engine clutch is through the gearbox in the normal way, and the power take-off is fixed. To engage the reduction gear and live power take-off the selector lever is first moved to the rear and the brake lever is then raised. When travelling like this it is only necessary to disengage this brake to stop the tractor, and the power take-off will continue to turn. To stop the power take-off when the reduction unit is engaged the engine clutch must be disengaged in the normal way.

The speeds using the reduction gear are: 0·55 m.p.h. in first gear at 1,000 r.p.m., and 4·4 m.p.h. in fourth gear at 2,000 r.p.m.; corresponding speeds with direct drive are respectively, 1·67 and 13·19 m.p.h. The live power take-off has several advantages, two of which are: a driver can control the height of a front-end loader without first having to engage neutral gear; an overburdened power take-off driven machine, such as a baler or a forage harvester, can be cleared quickly.

KALE CUTRAKE AND MOUNTED HARROW

Also on the Massey-Harris-Ferguson stand was an implement which will be particularly useful for dairy farmers the Kale Cutrake, (Fig. 7). This has a buckrake-type frame with a cutter bar at the end of the tines, and drive comes from the tractor power take-off to the centre of the knife, as shown; bull-nosed fingers are fitted on the cutter-bar to prevent spiking the kale. The method of operation is simply to back into the kale, cut a load, lift it, and transport the kale back to the cowshed or wherever it is required. Cutting an average load takes 12 seconds and its weight varies between 3 and 5 cwt. according to the type of crop. The implement eliminates the need to bring heavy trailers on to the field to collect the kale, and the short even stubble left on the land facilitates after-cultivation.

A new product from the Massey-Harris line of the joint organisation is a mounted model of the Massey-Harris spring-tine harrow for tractors fitted with category 2 linkage, illustrated in Fig. 8. The advantages of the trailed harrow are retained, in particular, flexibility, hard wear, and easy adjustments. Flexibility when working and rigid support in the transport position are ensured by three things: the tubular-steel mounting frame with flexible connections between harrow sections and three-point linkage; detachable swivel brackets on the front of the frame; heavy steel chain, clearly visible in the illustration, which supports the rear of the harrow clear of the ground for transport, yet allows complete flexibility when working.

The high-grade spring steel tines are easily adjusted or detached and are fitted with hard-wearing reversible points. The harrow is available in two and three section sizes with working widths of 5 ft. 7 in. (17 tines) and 8 ft 6 in. (26 tines), respectively.

AUTOMATIC DEFROSTING OF REFRIGERATING PLANT

Periodic defrosting of the evaporating coils in refrigerators is necessary to keep the plant working efficiently. A common practice is hot-gas defrosting, which is basically the passing of hot gas through the evaporator tubing at predetermined intervals, thereby heating it and melting any ice which has collected on the cooling surface. This system as at present used has certain disadvantages, the principal of which is that the temperature of the defrosting vapour at entry to the evaporator is not directly controlled, but depends on several factors such as ambient temperature, length of hot-gas line, pressure drop in hot-gas line, and the suction conditions of refrigerant entering the compressor.

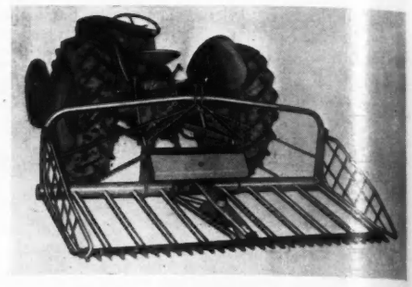


Fig. 7 The Kale Cutrake is backed into kale which it cuts and loads at the same time. Average time to cut a load of weight between 3 and 5 cwt., according to the crop, is 12 seconds.

In a system exhibited by the Refrigeration Division of the Pressed Steel Company, Limited, Cowley, Oxford, it is claimed that these shortcomings have been overcome by applying direct heat to the defrosting vapour at a point in the hot-gas line near to where it enters the evaporator. Any form of heating may be used, but in order to provide the best control of the temperature of the vapour entering the evaporator, direct electrical heating is preferred. In this way the maximum possible flow rate of defrosting vapour can be maintained at a high temperature level, and at the same time the heat content available for defrosting purposes does not depend on any external conditions. As the defrost vapour can be heated to any desired temperature just before it enters the evaporator, the variable effect of compressor heating now plays only a small part in the defrosting process. Similarly, it is no longer necessary to take into account any heat losses which may take place in the by-pass pipe between the compressor and the point of entry to the evaporator. This means that the heat content of the discharge vapour itself may be used in simple heat exchange with the suction pipe to re-evaporate any refrigerant liquid passing along this pipe during the defrost cycle, and in addition it may also be used for heating up the drip tray and drain in rooms which are held well below freezing temperature, if it is so desired.

In this type of installation the period of operation of the defrost cycle is controlled by an electric time switch which operates a solenoid valve in the hot-gas line, switches on the heaters, breaks the fan circuit, shorts out the room temperature thermostat, and switches on a warning

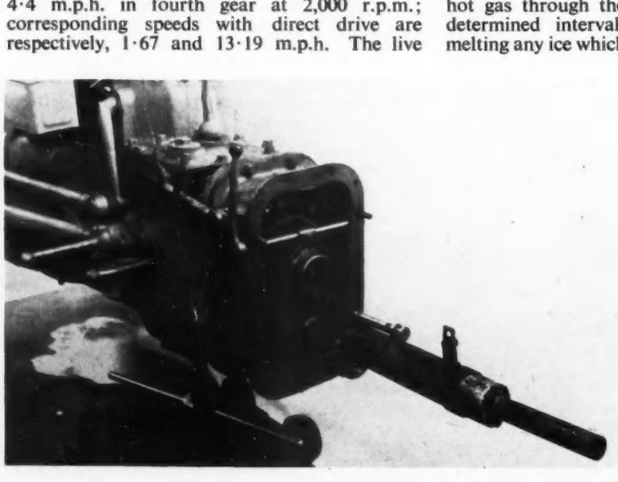


Fig. 6 This combined epicyclic reduction gear and live power take-off gives a 3 : 1 reduction and allows the tractor to come to a halt without the power take-off drive stopping. Control is by the two levers on the left side of the unit.

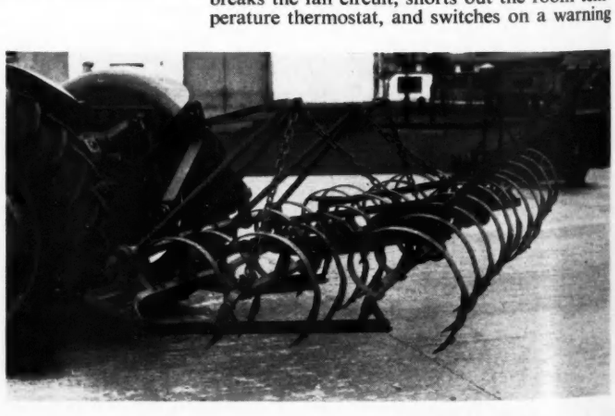


Fig. 8 A mounted version of the Massey-Harris spring-tine harrow; adjustment is quickly made by the levers at the back, and the chains support the rear of the harrow clear of the ground for transport, yet allow flexibility while working.

Fig. 9 The Tarpentiller is an electrically-operated tiller designed for cultivation to a depth of about 4 in. Each pair of blades is driven through automatic overload clutches which prevent damage if stones and other obstructions are encountered.

light at the start of the defrost cycle. Directly the solenoid valve opens, hot discharge vapour passes along the by-pass pipe and through a "defrost" heat exchanger, where it is under heat exchange conditions with the suction line, and heat from it evaporates any liquid returning to the compressor. The discharge vapour, some of which may have been condensed in the "defrost" heat exchanger, then passes into a "defrost" heater pot, where any liquid refrigerant is re-evaporated and the vapour heated up by means of a tubular type electrical heating element to a predetermined temperature level before passing into the evaporator coils. Between the heater and the evaporator the hot pipe is attached to the drain pipe and drip tray to ensure that the defrost water is not refrozen.

At the end of the defrost period the time switch cuts out the heaters, etc., and the system reverts to normal working. The standard liquid/suction vapour heat exchanger in the circuit not only increases the efficiency of the installation under normal working conditions, which is its primary purpose, but also has a subsidiary effect in that at the end of the defrost cycle it helps to minimise any chance of the liquid refrigerant remaining in the suction line getting back to the compressor still in the liquid state.

ELECTRICALLY-OPERATED HAND TILLER

A useful tool for the gardener or horticulturalist has been produced by the Tarpen Engineering Company, Limited, Ixworth House, Ixworthplace, London, S.W.3. It is an addition to their range of electrically-operated garden and agricultural tools and is called the Tarpentiller. There are two pairs of high carbon steel blades, as can be seen in Fig. 9, each pair being driven separately through automatic overload clutches to protect the mechanism against damage whenever stones or other obstructions are encountered. The driving motor is ½ h.p. and can be either universal direct-current or single-phase alternating current; voltages can be either in the 105 to 115 or 200 to 250-volt ranges.

Blade diameters are 6 in., each with three cutting teeth; the total width tilled is 5 in. The tillers rotate away from the operator, and the natural way to use the implement is to rest the tillers on the soil and allow them to go forward just fast enough to produce the required depth of tilth, the maximum depth being about 4 in. The Tarpentiller can be used either from the mains supply or through a transformer with 110-volt output for greater safety; the maximum distance it can be used from the nearest mains supply is 150 yards.

A chain saw head can be substituted for the hoe shaft and head, thus converting the machine into a light but powerful saw. The maximum cutting length of the saw is 12 in., but the recommended cut is 7 in. The complete weight of the machine with chain saw attachment is 14½ lb.

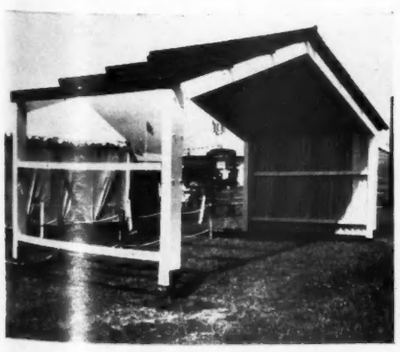


Fig. 10 The rigid frame construction designed by the Timber Development Association is shown here applied to a cow house. The single bay shown has a span of 22 ft. and height to the eaves is 8 ft.

TIMBER RIGID FRAME CONSTRUCTION

Since timber is a natural growth and with careful management can remain virtually inexhaustible, it is becoming progressively more important to find economic and mechanically sound ways of using it to fulfil functions at present performed by other materials. Much work along these lines is being done by the Timber Development Association, 21 College-hill, London, E.C.4, and at the Show they exhibited a number of designs of farm buildings made largely from timber. The Association's proposals are based on the use of the T.D.A. rigid frame system of construction, an example of which is the single bay of a cow house shown in Fig. 10.

This application of the rigid frame consists essentially of double timber post and rafter members connected together at the eaves and the ridge by bolting to pre-welded, cold-rolled or pressed-steel channel sections held in the timber sandwich. Single-sided toothed plate connectors are used in conjunction with the bolts to increase their load-bearing properties. It is intended that the frames should be made up by farm or estate labour; the timber can be prepared without difficulty to take the steel channel joint sections, bolts and timber connectors. The steel channel sections can be made up by the local blacksmith or metal worker from sheet steel, or obtained from a manufacturer if cold rolled channels are used. Each frame is assembled on the ground, and then raised and bolted into position on prepared foundations. The purlins are next fixed and the roof covering added. The roof is now complete, and the final stage is the construction of the infilling walls or sheathing as dictated by the requirements of the particular building.

Among the advantages of this type of construction are: ease of erection, since the rigid frames can be put up by semi-skilled or unskilled labour; the frames themselves can be made from a small number of standard parts; buildings made in this way can be readily converted to other uses, since there is complete planning freedom within the framework; the rigid frame system is economic in the combination of initial cost and subsequent maintenance.

The range of spans is based on a 3 ft. 8 in. planning grid. This module has been selected as a suitable dimension for doorway openings in farm buildings, and when used in multiples gives acceptable span sizes and bay widths for all types of farm buildings. Using a 20-deg. pitched rigid frame the following dimensions can be obtained: spans, 14 ft. 8 in., 18 ft. 4 in., 22 ft., 25 ft. 8 in., 29 ft. 4 in., 33 ft.; height to eaves 18 ft. except for the 33-ft. span where eaves height is restricted to 8 ft.; two purlin sizes of 11 ft. and 14 ft. 8 in. have been selected as being the two most suitable bay widths. The timbers that can be used are Douglas fir, longleaf pitch pine and shortleaf pitch pine for all spans over 14 ft. 8 in. For spans of 11 ft. and 14 ft. 8 in. the timber may be one of the following: European whitewood or redwood, western hemlock, Canadian spruce or European larch. The timber should be preserved to ensure long life, and its length of life is then estimated to make this form of construction as or more economic than any other. Although first cost may be slightly higher, maintenance costs are virtually eliminated.

* * *

LAUNCHES AND TRIAL TRIPS

M.S. "CRYSTAL CUBE."—Single-screw vessel for carrying sugar in bulk, built and engined by Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, for the Sugar Line, Ltd., London. Main dimensions: 430 ft. by 61 ft. by 37 ft. 4 in.; deadweight capacity, 9,740 tons on a draught of about 24 ft. 6¾ in. Scott-Doxford four-cylinder opposed-piston oil engine, developing 3,300 b.h.p. Trial trip, June 22 and 23.

M.S. "ST. BLANE."—Single-screw coasting vessel, built by James Lamont & Co., Ltd., Port Glasgow, for J. and A. Gardner & Co., Ltd., Glasgow. Main dimensions: 128 ft. 6 in. by 29 ft. by 13 ft.; deadweight capacity, 850 tons. Diesel engines with reverse-reduction gearing, constructed by the English Electric Co., Ltd., Rugby. Launch, June 23.

M.S. "THOR ODLAND."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Burmeister and Wain Ltd., Copenhagen, Denmark, for D/S A/S Produce (associated with Jacob Odland S.S.), Haugesund, Norway. Main dimensions: 400 ft. between perpendiculars by 55 ft. 6 in. by 35 ft. 6 in. to upper deck; deadweight capacity, 6,850 tons on a draught of 24 ft. 4 in.; cargo-carrying capacity, about 430,000 cub. ft. (bales). Six-cylinder single-acting two-stroke cross-head Diesel engine, developing 7,100 i.h.p. at 125 r.p.m., and arranged for burning heavy oil. Launch, June 29.

H.M.S. "RIPLINGHAM."—Inshore minesweeper, built by Brooke Marine, Ltd., Lowestoft. One of a series of these vessels being constructed in the United Kingdom by this firm under the United States Off-Shore Procurement Programme. They have a length of 106 ft. 5 in., a breadth of 20 ft. 6 in., are of all-wood construction and are designed to operate in shallow waters. Trial trip, July 1.

M.S. "ESCALANTE."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Harland & Wolff, Ltd., Govan, Glasgow, for the Royal Mail Lines, Ltd., London, E.C.3. A series of six other cargo vessels is on order for these owners. Main dimensions: 415 ft. between perpendiculars by 58 ft. 6 in. by 38 ft. 4 in. to shelter deck; gross tonnage, about 7,450. Harland-B. and W. six-cylinder single-acting two-stroke Diesel engine, arranged to operate on heavy fuel or Diesel oil. Launch, July 5.

M.S. "LAGANBANK."—Single-screw cargo vessel, built and engined by Harland & Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. This ship is the last of a series of six vessels being constructed for these owners; and a second series, of six larger ships, has been ordered. Main dimensions: 425 ft. between perpendiculars by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder single-acting two-stroke Diesel engine. Launch, July 5.

M.S. "HERMES."—Single-screw oil tanker, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for Bruusgaard, Kiosterud & Co., Drammen, Norway. Main dimensions: 510 ft. between perpendiculars by 68 ft. by 38 ft.; deadweight capacity, 16,300 tons. Rowan-Doxford five-cylinder opposed-piston heavy-oil engine, developing about 6,200 b.h.p., constructed by David Rowan & Co., Ltd., Glasgow. Mean trial speed, 14¾ knots. Trial trip, July 5.

M.S. "PORTSLADE."—Single-screw cargo vessel, built by Austin and Pickersgill, Ltd., Sunderland, for Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 231 ft. by 40 ft. 2 in. by 17 ft. 10½ in. to upper deck; deadweight capacity, 2,325 tons on a mean summer draught of 17 ft. Clark-Sulzer eight-cylinder single-acting two-stroke trunk-piston oil engine, constructed by George Clark (Sunderland Ltd., Sunderland. Service speed, 11 knots. Launch July 6.

ROADS FOR MOTOR TRAFFIC ONLY

345 MILES TO BE BUILT WITHIN TEN YEARS

"Motorway" is the designation of Britain's equivalent to the American superhighway, the German autobahn and the Italian autostrada. The first stages in the building of motorways to speed the movement of road traffic were announced by Mr. John Boyd-Carpenter, Minister of Transport and Civil Aviation, on July 5. The London-Yorkshire motorway will start from the northern end of the proposed St. Albans by-pass, and the first stage in its construction will be the 53 miles to Dunchurch, near Birmingham, the stretch shown by a heavy unbroken line in Fig. 1. On this stretch there will be six flyover junctions for drivers to turn off or join the motorway without holding up or slowing down the main stream of traffic.

It is proposed to authorise construction of the whole of this road within the next three years. The building of the second stage of the London-Yorkshire motorway, about 107 miles, is to follow the completion of the first section. A length of motorway between a point north of Birmingham and the Preston by-pass, about 94 miles, will be started while work on the first stage of the London-Yorkshire section is still in progress.

Other roads for motor traffic only, which it is hoped to authorise within the next three years, are by-passes at St. Albans, Doncaster, Preston, Lancaster, Maidenhead, Maidstone and Ross Spur, the length of all these together being 84 miles. The St. Albans and Doncaster by-passes will form the terminals of the London-Yorkshire motorway. Two others, the Preston and Lancaster by-passes, will eventually form part of the Birmingham-Shap motorway. The Maidenhead by-pass is part of the proposed South Wales motorway and the connections to the existing highway system on either side of Maidenhead are also part of the ultimate motorway layout. Maidstone by-pass is on the route of the present trunk road, A.20 (London-Folkestone-Dover).

The total cost of all the roads announced in the first stages is £85 million, which gives an average cost of about £250,000 per mile.

TWO AND THREE LANE DUAL CARRIAGEWAYS

The motorways will be constructed to modern standards with hard shoulders adjacent to the carriageways, as shown in Figs. 5 and 6, so that vehicles can pull up in emergencies clear of the running lanes. The actual carriageways are defined on either side by a marginal strip in contrasting colour, each strip being 1 ft. wide. The carriageways will be designed to provide for lane travel and each traffic lane will be 12 ft. wide; on the section of the London-Yorkshire motorway between St. Albans and the spur to Birmingham at Ashby St. Ledgers there will be two three-lane carriageways as on this section the road will carry, in addition to the heavy industrial traffic to Birmingham, the industrial traffic to the north-east. The question whether there should be dual two-lane or dual three-lane carriageways on the other motorways is now being investigated in the light of the traffic figures revealed by the traffic census taken in August, 1954. The method of defining the lanes in each carriageway has not yet been decided.

In general, lighting on motorways will be provided where they pass close to large centres of population. At these points the volume of traffic will be heavy, and lighting will be necessary to enable vehicles entering and leaving the motorway to do so in safety. The standard of lighting will be that installed on the best arterial roads.

LANDSCAPE TREATMENT AND THE USE OF TREES

Landscape treatment of motorways will have two main objectives—to promote safety and to ensure that the introduction of the motorway does not result in the scarring of the countryside. Methods of achieving these objectives are being closely studied, but in general it can be said that the following principles will be observed. Planting will be used to break the monotony of line, to emphasise points of interest and to screen where desirable. Regular rows of trees will be avoided as they tend to accentuate the line of the road and become monotonous and soporific in effect, especially at speed.

The first consideration is that of safety. "sight" lines must not be obstructed, particularly on curves, and at connections. On the other hand, the combination of ground elevation and planting will help to reduce the dangers of headlight glare. Light-stemmed, foliaged trees and shrubs have great value in breaking up headlight glare at night. The planting of large trees close to the carriageway will be avoided. The spread of large trees tends to force vehicles out from the edge of the road and there is also a danger from fallen branches. After rain tree-shade also creates intermittent wet patches on the road surface. Care will be taken to avoid the creation of pools of deep shadow which impair the motorist's vision. Planting will be undertaken where necessary to stabilise soils, particularly on cuttings and embankments where the prevention of soil erosion is a matter of importance to road safety.

Although refuelling stations and eating places will be provided along the routes, there will be no permission given for shops or factories to be built near the motorways, and access will be limited to the planned intersections—six in the case of the first 53 miles of the London-Yorkshire motorway. Surveys have already been made for the line of the London-Yorkshire motorway, and the Minister hopes to publish the proposals in September. There will then be a period of three months during which objections can be entered, followed by a public inquiry. When the line has been settled the land must be acquired, and it is hoped that constructional work will start in about two years time.

THE LONDON-YORKSHIRE MOTORWAY

The first section of the London-Yorkshire motorway runs as far as Dunchurch, a distance of 53 miles. In this first section there will be six flyover junctions, which are described in more detail below, 46 public road bridges, eight railway bridges, three canal bridges, five river bridges and many public paths, private access and agricultural access bridges.

From its starting point on the proposed St. Albans by-pass to its junction with the proposed Dunchurch by-pass near Birmingham the motorway has been designed to allow an uninterrupted flow of traffic. Except at the flyover junctions there will be no access to the motorway, as at present planned, at any point between the terminals, but consideration is being given to the question of providing emergency access for special traffic such as fire engines and ambulances. Simple connections for this purpose might be made by means of slip roads.

The first of the proposed flyover junctions will be built at the crossing of the Dunstable-Luton Road, route A505. At this point the motorway will be raised on an embankment about 25 ft. high. It will be linked by four slip roads to a roundabout built under the motorway on the level of the existing road. This type of flyover is shown in Fig. 3.

The slip roads begin about 100 yards from the junction to avoid steep gradients and also to allow time for deceleration and acceleration—an important point as vehicles on the motorway

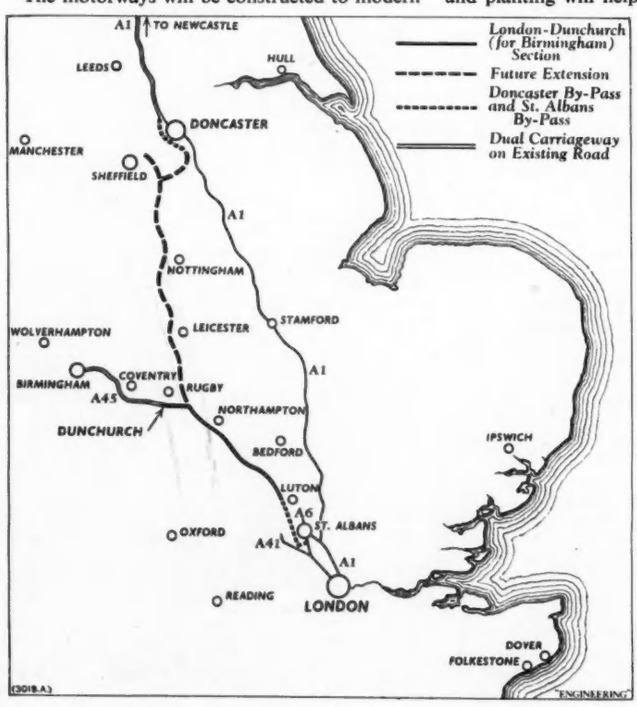


Fig. 1 In addition to the London-Yorkshire motorway shown on this map, it is proposed to authorise a further motorway between Birmingham and Preston in the next three years, and a number of by-passes.

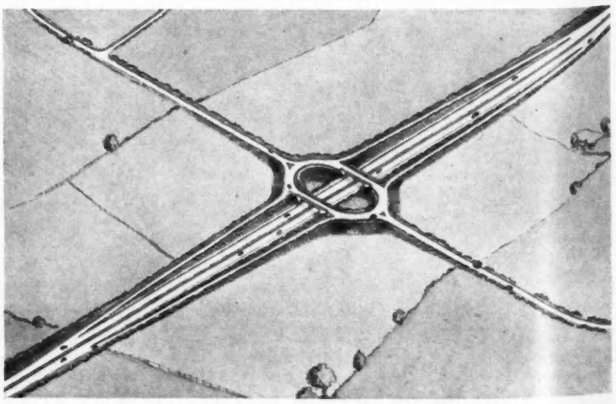


Fig. 2 This type of flyover junction, with overhead roundabout carried on two concrete bridges, will be built on the first section of the London-Yorkshire motorway at its intersections with A50 and A45.

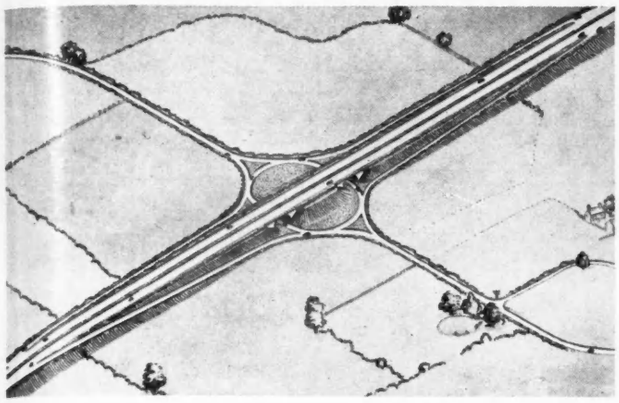


Fig. 3 Flyovers with roundabouts under the London-Yorkshire motorway will be built at its intersections with the Dunstable-Luton road (A505).

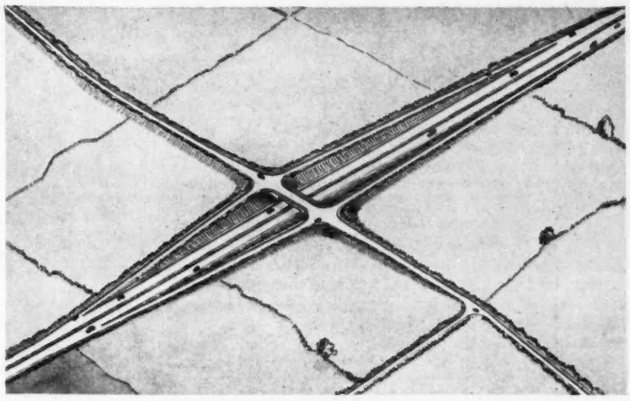


Fig. 4 Flyovers without roundabouts will be built where the traffic coming on and off the London-Yorkshire motorway is only moderately heavy.

will be moving at high speeds. In no case will gradients on slip roads exceed 1 in 25. The slip roads will merge almost imperceptibly into the motorway, thus enabling drivers coming from the roundabout to accelerate and take up their position on the motorway without hindering other traffic.

The inside dimensions of the roundabout will be 150 ft. by 320 ft. It will be connected with the Dunstable-Luton Road on the east and west sides by splayed junctions each with a central triangular island. Where the two sides of the roundabout pass under the motorway three-span concrete bridges will be built. The central span will accommodate the carriageway, and the outer spans the cycle track and footpath which are to be continued from the existing road.

INTERSECTIONS WITHOUT ROUNDABOUTS

Within the next 10 miles the motorway passes under two roads which carry a considerable volume of brick traffic as well as other miscellaneous traffic, the Toddington-Ampthill Road, A5120, and the Husborne Crawley-Brogborough Road, B557. Traffic on these roads is not heavy enough to justify a flyover with a roundabout, and connection will be made in each case by means of four slip roads of standard pattern. These slip roads will form T-junctions with the existing roads, which will be widened locally to allow turning room and raised on embankments to cross the motorway; this type of intersection is shown in Fig. 4. On route B557 the embankment will be extended southwards for half a mile from the junction to eliminate a railway level crossing.

Shortly after crossing the Bedfordshire-Buckinghamshire boundary, the motorway passes in a shallow cutting under the Newport Pagnell-Woburn Road on Route A50. Here the first of a series of three flyover junctions incorporating a roundabout above ground will be constructed, the general form of which is clearly shown in Fig. 2. The next two flyovers of this type will be at the junctions with the Stony Stratford-Northampton Road, A508, and the Weedon-Northampton Road, A45. In each case the approaches of the existing road will be raised on embankment to the level of the proposed roundabout, which will be carried over the motorway on two concrete bridges. Each bridge will have two spans to accommodate the dual carriageways on the motorway. The roundabout will be connected with the motorway by four slip roads.

SKEW CROSSINGS

At the first of these junctions, the existing Newport Pagnell Road crosses the line of the motorway diagonally and because of the skew crossing the roundabout will take the shape of an elongated oval with inside dimensions of 200 ft. by 550 ft. The roundabout at the flyover junction with the Stony Stratford-Northampton Road will be of more conventional shape, 200 ft. by 420 ft. This junction will provide access for north and south traffic to and from Northampton.

Another skew crossing will be formed by the junction of the motorway with the Weedon-Northampton Road, Route A45, near Upper Heyford. The existing road at present crosses the line of the motorway at an acute angle. It will therefore be diverted on the south side of the motorway and rebuilt on an improved alignment, joining the high-level roundabout on an embankment 25 ft. high. Even so, an elongated roundabout will be necessary, measuring 200 ft. by 500 ft. This junction is expected to take a large volume of traffic to and from Rugby and Coventry as well as Northampton traffic. Where the motorway crosses the flood plain of the River Ouzel or Lovat it will be built for three-quarters of a mile on embankment including a viaduct 400 ft. long. Embankments with viaducts will also carry the road over the flood plains of the Great Ouse and the River Nene.

For five miles before turning westwards towards Birmingham the motorway will follow a route used by transport through the ages. The Romans went this way when they built Watling Street, and the main-line railway to Rugby and the Grand Union Canal run nearly parallel with the old Roman Road. The country is undulating and for a mile and a half after passing over the Daventry-Long Buckley Road the motorway will be on high embankments up to 35 ft. and in cuttings of about 15 ft. The motorway then rises on embankments 25 ft. high to pass over the canal just north of the Watford Locks and immediately afterwards goes into a 30-ft. cutting to reach the point from which it is proposed to extend it at a later date to Doncaster. At this point, to be known as the Birmingham Junction, the plans allow for the future construction of a flyover. Where the motorway joins the Dunchurch by-pass a traffic roundabout will be built at ground level.

* * *

ALUMINIUM FOR LORRY TIPPER BODIES

Redhill Bodybuilding Industries Limited, Hooley-lane, Redhill, Surrey, have now completed the construction, in wrought aluminium alloy, of two tipper bodies of 15 tons pay-load and having internal dimensions of 17 ft. by 7 ft. by 2 ft. 9 in., mounted on A.E.C. Mammoth III eight-wheel chassis. The bodies have been constructed for Associated Portland Cement Manufacturers, Limited, for use at their Welsh quarries, where limestone rock is quarried by opencast methods and loaded by mechanical shovels. It is stated that an all-aluminium body withstands well the heavy impact loads encountered, has an increased life and represents a substantial saving in weight compared with bodies constructed of other materials.

The rivets used in the construction were of a 5 per cent. magnesium-aluminium alloy and the bolts were of cadmium-plated high-tensile steel, with self-locking nuts.

* * *

"Castrolite" marketed by C. C. Wakefield and Company, Limited, 46 Grosvenor-street, London, W.1, is a multi-grade automobile engine oil which covers the range S.A.E. 20W, 20, and 30. It is thin enough when cold to meet any climatic extremes in the United Kingdom and contains additives for improving the viscosity index and for reducing oxidation and corrosion.

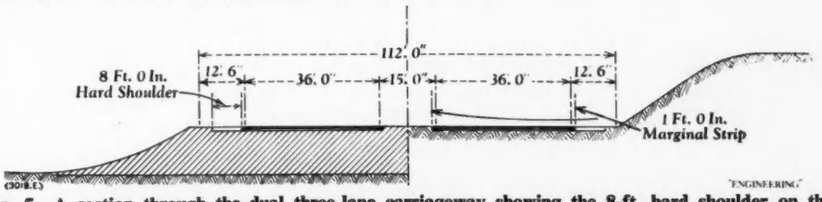


Fig. 5 A section through the dual three-lane carriageway showing the 8-ft. hard shoulder on the outside of each carriageway to allow vehicles to pull off in emergencies.

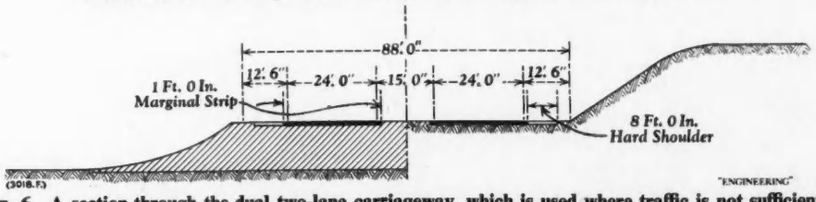


Fig. 6 A section through the dual two-lane carriageway, which is used where traffic is not sufficiently heavy to warrant three lanes. The 1-ft. marginal strips indicate the edges of the carriageways, and are coloured differently to the traffic-bearing part of the road.

DOWN-GRIP MACHINE VICE

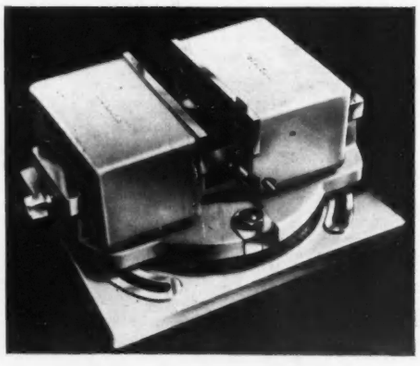
The Dormer machine vice has been designed by the Sheffield Twist Drill and Steel Company, Limited, Summerfield-street, Sheffield, 11, to ensure that the work is gripped positively without any possibility of upward lift. The vice, which is similar in general appearance to one of conventional design, and is used in the same way, combines rapid adjustment for work-size with a lever mechanism which ensures that the jaws remain square with each other and with the base at all times, and actually exert a downwards pull on the work as it is gripped. The dimensions of the vice at present in production are; maximum opening of jaws, 3⅞ in., width of jaws, 6¼ in., depth of jaws, 1⅞ in., height from base to top of jaws, 5¾ in. The body of the vice is swivel-mounted on the base, and can be rotated through 360 deg., a scale graduated from 0 to 360 deg. being provided for setting purposes.

The standard jaws are of hardened steel, held in place by socket-head screws, and are reversible to allow shallow V-grooves on the back to be brought to the front for gripping by line contact rough, irregular, out-of-square work, which would normally tilt when gripped. This arrangement also preserves the datum faces for accurate work. Soft jaws can be provided if required. One of the jaws is used solely for exerting the gripping force through the medium of a screw and hand-lever. The other jaw is quickly adjustable by means of two thumb-triggers to enable it to be set to the work-size.

The side-walls of each jaw have internal slots, one on each side, to accommodate a pair of links, which are pivoted to the jaw by a common link pin. The links on the adjustable jaw carry at their lower extremities, by means of trunnions, a pawl member which has teeth normally spring-held in engagement with matching teeth on the underside of the slide. Thumb-triggers extend through the slots in the jaw body to enable the pawl to be disengaged from the toothed slide when the jaw requires to be drawn back away from the gripping jaw. To close the adjustable jaw it is only necessary to push it, the pawl springing over the slide teeth like a ratchet.

The arrangement of the gripping jaw is similar except that the lower ends carry a block against which the end of the clamping screw abuts. A lug on the vice base houses a phosphor-bronze nut for the clamping screw which, when it is turned in a clockwise direction, pushes against the block and so moves the jaw inwards to clamp the work.

The relative positions of the pivot pins and trunnions at the two ends of the links in each jaw are such that there is a leverage about the lower pivot points, and any tendency of the jaws to lift under the clamping load is counteracted by a downwards movement about the lower pivots. The jaws are thus pulled hard down on to the slide, and the work is held square with the slide and with the jaws.



When a component is gripped by the Dormer machine vice, a lever action causes the jaws to exert a positive downwards pull.

Labour Notes

MINERS' HEAVY DEMANDS

Many people will tend to regard the demands put forward by the National Union of Mineworkers at the union's annual conference last week as being essentially extravagant and that view will be much strengthened by the heavy increases in the price of coal which the National Coal Board announced last Friday.

The conference, which is being held at Rothesay, opened on Monday of last week and the second day was largely devoted to the consideration of wages, hours of work and paid holidays. Unanimous support was given for a proposal by the union's executive committee that the Board should be urged to restore the seven-hour working day for underground miners and to introduce a 40-hour week for all surface employees. The union's general secretary said that a promise had been given by the then Labour Government, nearly ten years ago, that such action should be taken.

Another resolution, approved unanimously, called upon the executive committee to enter into early negotiations with the Board for the introduction of three weeks' annual holiday with pay, in addition to the six days' statutory holiday. At present, the miners receive two weeks' paid holiday each year.

Mr. Abe Moffat, President of the union's Scottish area, moved that an increase of 15*s.* a week should be demanded in miners' present rates of pay, and suggested that the proposal should be remitted to the executive committee, for consideration with other claims for improvements. This was agreed to without dissent.

NEW WAGE STRUCTURE

The principal arguments put forward by the delegates in support of the motion to increase rates of pay were that prices of many commodities and especially of food, had risen considerably, that the men were working harder, and that better pay would attract the recruits the industry so urgently needed. Another contention was that the present minimum wage was too low unless augmented by pay for overtime.

A report was given by Mr. A. Horner, the general secretary, on the introduction last April of the new pay structure for day-wage men. He said that the union and the National Coal Board were about to begin negotiations on a new structure for miners engaged on piece rates. These talks would provide an opportunity for obtaining greater security for these men, possibly through the introduction of a time basis of payment.

In this connection, Mr. Horner made the point that more than 95 per cent. of all pit strikes were caused by disputes over piece rates. Conditions differed widely from pit to pit and, however difficult it might be, a system of greater justice must be found.

During the ensuring discussion, a number of delegates complained either about the day-wage men's pay structure or about the manner of its introduction. This dissatisfaction was pressed to such an extent that Mr. Horner was eventually moved to remind the delegates that the new structure had added about £14 million to the Board's annual expenditure and that, therefore, someone must have benefited in some way.

END RESTRICTIVE PRACTICES

Anomalies in the present shift system were discussed on the third day of the conference. The delegates approved a suggestion by the executive committee that they should be authorised to press for an early termination of the existing system, whereby miners are paid for six shifts if they work five shifts in any week.

It was contended that the money saved by the elimination of the "bonus shifts" should be used to raise by 20 per cent. the payment for each shift worked. Arguments in favour of the abolition of the six-for-five system were that it had not discouraged absenteeism as much as had been expected and that the anomalies which had resulted from its application were the cause of many disputes.

At an earlier session, the delegates were addressed by the chairman of the National Coal Board, Sir Hubert Houldsworth, who urged that shortages of manpower must not be allowed to excuse unnecessary hindrances to the production of coal. When all types of manpower, administrative, technical and manual, was in short supply, none of it should be wasted.

Sir Hubert appealed to the union to remove all restrictive practices in the industry, however hallowed they might be by tradition, and said that such practices simply could not be justified on any grounds. He also asked for an end to unofficial strikes and for further improvements in the level of attendance.

On the question of which of the union's claims should have precedence, the delegates were reminded by their chairman that each demand would cost money and that the best way to help the Board would be to assist in the recruiting of another 17,000 men. If that were done, another 5¼ million tons of coal could be produced thereby providing the industry with another £30 or £40 million of income.

It was reported that about four-fifths of the industry's labour force eligible to join the pension scheme had done so. The pension fund, the supplementary injuries fund and the union's staff superannuation fund together totalled nearly £90 million, all of which had been invested. It was expected that the amount invested would eventually exceed £500 million.

ANOTHER RAILWAY PAY CLAIM

Hastings was chosen as the venue of the annual conference of the National Union of Railwaymen, which also took place last week.

On the fifth day of the meeting, the delegates passed a resolution that a new claim should be made against the British Transport Commission for higher wages; the amount to be demanded and the time of presentation being left to the union's executive committee. The intention behind this reservation to the proposed claim appears to be to enable the committee to consult with the other railway unions, in an endeavour to obtain agreement respecting the industry's pay structure. It might then be possible to present a joint claim on behalf of all railway employees.

In his report at the opening of the conference, Mr. J. Campbell, the union's general secretary, described the recent railway strike by footplate men as regrettable, but expressed the hope that the unions would quickly resume that co-operation which had served them so well. It had, he said, always been his conviction that concentration on differentials would only divert the unions from raising the general level of railway wages. That was the main objective.

AUTOMATION INQUIRY REJECTED

Replying to a parliamentary question on July 7, Sir Walter Monckton, the Minister of Labour, told the House of Commons that a great deal of attention was being given to the spread of automatic processes and the development of automatic factories. For this reason, he did not consider that there was any need for a special inquiry by his Ministry into the possible effects of automation on employment.

Sir Walter was then asked whether he was aware of the widespread fears existing among industrial employees that automation would bring serious unemployment unless hours of work were cut and the purchasing power of the community increased; and whether it was not preferable to investigate the problem now, rather than wait until distress had arisen.

The Ministry of Labour, Sir Walter said, were considering that aspect of the question and he had himself observed what had been stated by leaders of a number of trade unions. It appeared to be unnecessary to have a special inquiry at the present time, but an investigation into the technical aspects of automation was being conducted by the Department of Scientific and Industrial Research.